SOUTH CAROLINA CoEE

CENTERS of ECONOMIC EXCELLENCE

2008-2009 Annual Report to the S.C. General Assembly and the S.C. Budget & Control Board

MUSC MEDICAL UNIVERSITY of SOUTH CAROLINA

UNIVERSITY of SOUTH CAROLINA

CLEMSON UNIVERSITY

FRONT COVER PHOTOGRAPH: JOHN WALKER, SENIOR SIMULATION SPECIALIST FOR THE CLINICAL EFFECTIVENESS & PATIENT SAFETY COEE, A COLLABORATION BETWEEN USC AND MUSC, ENGAGED IN HIGH FIDELITY PATIENT SAFETY TRAINING AT THE MUSC SIMULATION CENTER IN CHARLESTON.

REAR COVER PHOTOGRAPH: (FROM LEFT) PH.D. STUDENT XINFANG JIN, POSTDOCTORAL CANDIDATE CUIFANG KUANG, AND DR. CHRIS XUE, ASSISTANT PROFESSOR IN THE USC DEPARTMENT OF MECHANICAL ENGINEERING, SHARE A SUCCESSFUL EXPERIMENTAL OUTCOME IN THE SOLID OXIDE FUEL CELLS COEE LABORATORY AT USC.

South Carolina Centers of Economic Excellence 2008-2009 Annual Report to the S.C. General Assembly and the S.C. Budget & Control Board

Representative Robert W. Harrell, Jr.
S.C. Speaker of the House

"Because of our state's investment in public-private scientific research, I fully expect to see the technological innovations of the near-future and beyond stamped ***'MADE IN SOUTH CAROLINA.'"***

MESSAGE FROM THE S.C. SPEAKER OF THE HOUSE

In 2000, a group of South Carolina legislators and businesspeople took an economic development scouting mission to the North Carolina State University Centennial Campus Research Park, a 1300-acre research and development "technopolis," as its developers describe it. Today, Centennial Campus boasts 61 corporate and government partnerships, 70-plus research centers, and ultimately is projected to employ more than 25,000 North Carolinians.

As a member of the South Carolina group that toured Centennial Campus, I saw firsthand how corporations and public universities can collaboratively boost the economic prosperity of a community. North Carolina has made a 60-year investment in research and technology development. While the fruits of R&D can take years to come to fruition, the payout is remarkable: North Carolina contractors now earn more than $450 million per year in federal contract expenditures, and the state consistently scores at or above the national average in knowledge economy indicators.

But, to me, the real important statistic is that Wake County, the location of Centennial Campus, boasts one of the highest per capita incomes in the nation. This is no coincidence, I assure you.

In 2002, South Carolina began making the transition to become a knowledge economy leader. The General Assembly started investing State Education Lottery proceeds into academic research centers at the state's three public research universities: USC, Clemson and the Medical University of South Carolina. The results to date have been nothing less than extraordinary.

South Carolina has built 45 Centers of Economic Excellence in cutting-edge fields that diversify our state's economy and position us competitively in the national and global economy. The prestigious Washington Advisory Group published a comprehensive evaluation of the CoEE Program in January 2009, which touted the CoEE Program as the best program of its kind in the nation.

The CoEE Program is not science for science's sake. Because of the CoEE Program, more than one quarter billion private and federal dollars have been directly invested into the South Carolina economy, with several thousand jobs created as the result. But this is just the tip of the iceberg.

Because of the world-renowned scientists (CoEE chairs) being recruited to South Carolina, major companies are relocating just to be near them, companies like American Titanium Works, which recently announced a $422 million development and engineering relocation which will create more than 300 Upstate jobs near the Clemson University International Center for Automotive Research (CU-ICAR) campus.

As I write this, the CoEE chairs are working to translate laboratory discoveries into marketable products. In time, these new technologies will generate a new manufacturing sector for our state, one based on scientific discovery. Because of our state's investment in public-private scientific research, I fully expect to see the technological innovations of the near-future and beyond stamped "Made in South Carolina."

MESSAGE FROM THE S.C. SENATE FINANCE COMMITTEE CHAIR

The CoEE Program mandate to create new jobs and economic opportunities in South Carolina does not extend just to the major metropolitan areas, home to our public research universities. The revitalization of the state's economy through public-private research and development partnerships means transforming every corner of the Palmetto State, from the Foothills to the Pee Dee to the Lowcountry.

As any doctor can tell you, treating a rural stroke patient is no picnic in the park. Stroke victims require complex examination and treatment within hours of the onset of stroke in order to prevent long-term negative health effects. However, through the work of stroke specialist and CoEE Chair Dr. Robert Adams of MUSC, the CoEE Program is leading a revolution in rural stroke medicine.

Through Dr. Adams' REACH Network, the Stroke CoEE now provides vital telemedicine treatment to rural South Carolina stroke victims, including patients at the McLeod Regional Medical Center in Florence. From April 2007 to April 2008, only 27 patients at the six rural hospital sites now within the REACH Network were administered a potentially lifesaving stroke treatment called tPA. Since April 2008, more than 200 rural South Carolinians at these six sites have been treated and examined by stroke specialists in Charleston, with nearly one-third of patients receiving the vital tPA treatment.

The CoEE Program also impacts rural areas of the state through numerous biomedical research centers, including the Cancer Disparities CoEE, a collaboration between MUSC, USC and South Carolina State University, which works to increase prostate cancer screening and early detection, especially among African-American populations. South Carolina's diverse population presents amazing opportunities for clinical trial work, which is a critical stage of pharmaceutical and biomedical manufacturing.

Clinical trials are the means by which pharmaceutical and medical device companies ensure product safety and effectiveness before a new technology is approved for the market. Through the clinical trial work of CoEE researchers all over the state, South Carolina is creating an enticing environment for entrepreneurs and venture capitalists to establish biomedical start-up companies and for major health companies to relocate research and manufacturing facilities in South Carolina.

Biomedical product development requires patience. Federal approval for healthcare-related technologies can take a decade. But the payoff can be well worth the wait. In 2005, Emory University received more than $500 million for its role in the discovery and invention of the HIV drug Emtriva.

Senator Hugh K. Leatherman, Sr.
S.C. Senate Finance Committee Chair

"The CoEE Program impacts South Carolinians of all backgrounds in every corner of the state."

In addition to its impact on the economy, the CoEE Program is improving quality of life in South Carolina. A perfect example is the SeniorSMART Center, a collaboration between USC and Clemson. This CoEE focuses on research areas relevant to the aging mind and body, such as ways to maintain a healthy brain, improve physical mobility and driving ability, and design or retrofit homes to suit the needs of older adults. An offshoot of this Center's research are personal care programs offered to community seniors to help them maintain independence.

The CoEE Program is impacting South Carolinians of all backgrounds in every corner of the state. And this is the only way to truly revitalize an entire state economy, person by person, town by town.

"Imagine one million dollars piled high on a table. Now imagine a pile 230 times that amount … This is the impact of the CoEE Program so far — which is the tip of the economic iceberg."

Message from the CoEE Review Board Chair

At a time when much of the country is staring down the barrel of economic uncertainty, and the last thing anyone wants is "financial" in his or her job title, the Centers of Economic Excellence Program is celebrating unparalleled success. To date, more than **$232 million** in non-state funds have been invested into our state economy and nearly **3,200 jobs** have been created through 45 public-private partnership research centers known as Centers of Economic Excellence, or CoEEs.

Nearly half ($113 million) of this almost quarter-billion-dollar total is comprised of dollar-for-dollar partnership matches which each CoEE must raise in order to access state award funds. The other half ($119 million) is composed of research grants awarded from corporations and federal agencies over and above program matching requirements. These extramural grants are awarded to the unique CoEE endowed professors and researchers who have been specially recruited to South Carolina in order to turn our state into a knowledge-based economy leader.

Beyond even these totals are the hundreds of millions of dollars which have been—and are being—invested in South Carolina by major corporations to relocate research and development facilities and by venture capitalists to create new technology start-up companies.

Imagine one million dollars piled high on a table. Now imagine a pile 230 times that amount. Now imagine all of that money gone. Even harder to imagine is 3,200 jobs suddenly disappearing from cities and counties all across the Palmetto State. This is the impact of the CoEE Program so far—which is just the tip of the economic iceberg.

CoEE Review Board Chair Paula Harper Bethea, pictured with (l to r) Clemson University President James Barker, USC President Harris Pastides, and MUSC President Raymond Greenberg.

The 45 CoEEs cover the entire spectrum of academic research and development and are shining examples of institutional collaboration which is drawing, quite literally, the awe of research and investment communities worldwide. In fact, this past January, the esteemed Washington Advisory Group described the CoEE Program as "a best-in-kind program that is, or should be, the envy of other states."

One of the most exciting events of the past year was the designation of MUSC's Hollings Cancer Center as a National Cancer Institute Cancer Center—one of only 64 centers in the country. MUSC was also the recent recipient of two $20 million grants: a National Science Foundation grant to establish a statewide tissue biofabrication alliance and a coveted National Institutes of Health Clinical Translational Science Award for turning laboratory discoveries into patient treatments and medical technologies.

At USC, CoEE researchers are designing fuel cells and nuclear power plants which will fill our energy needs in the near future and beyond. This past year, Columbia hosted the National Hydrogen Association annual conference, which was headlined by two fuel cell USC CoEE Chairs and which showcased South Carolina's commitment to knowledge-based research to international industry. USC was also awarded its single largest federal grant ever, a $12.5 million U.S. Department of Energy award for advanced energy research to CoEE Chair Dr. Ken Reifsnider and his research team. And global medical giant Smith & Nephew announced a $5 million partnership with USC's Rehabilitation and Reconstruction Science CoEE to develop tissue-engineered materials and implantable devices.

(l to r) **USC President Harris Pastides, CoEE Chair Paula Harper Bethea, and BlueCross Blue Shield of SC President & CEO Ed Sellers**

The Clemson University International Center for Automotive Research (CU-ICAR) has generated such an innovative buzz that corporations like American Titanium Works are investing hundreds of millions of dollars in the Upstate to relocate facilities near Clemson's four CoEE automotive engineering chairs. At CU-ICAR, the nation's first automotive engineering doctoral program is attracting the brightest engineering students in the country, many of whom are considering staying in the Palmetto State following graduation. And Clemson scientists at the Photonic Materials CoEE have developed a practical optical fiber which could have a profound impact on efficiency in light-based and electronic devices worldwide.

As the presidents of all three South Carolina research institutions will eagerly tell you, the above accomplishments would not have been possible without the CoEE Program. In 2003, the South Carolina General Assembly took an "if you build it, they will come" approach to reinventing the state economy. After a few years, we now see that industry and investment aren't just coming, *they're coming in droves*. But building a train engine and laying miles of track is not all that is required to get from Point A to Point B. It takes dynamic effort to get a train moving and equal energy to sustain an engine's propulsion. The knowledge-based economy is no different.

Over the past several years, the General Assembly has made critical initial investments in academic research infrastructure and the incredible brain trust required to jumpstart the new South Carolina economy. Now that the knowledge-based economic train is successfully heading down the track, the hope of the CoEE Review Board is that the General Assembly will continue to fund this remarkable program.

Because one thing is for certain: the future will not invest in itself. We must invest in and therefore create our own bright future.

Paula Harper Bethea

Brain Imaging

Molecular Proteomics

Cancer Drug Discovery

"The General Assembly finds that it is in the public interest to create incentives for the senior research universities of South Carolina consisting of Clemson University, the Medical University of South Carolina, and the University of South Carolina to raise capital from the private sector to fund endowments for professorships in research areas targeted to create well-paying jobs and enhanced economic opportunities for the people of South Carolina."

GI Cancer Diagnostics

Nanoenvironmental Research & Risk Assessment

Medication Safety & Efficacy

Supply Chain Optimization & Logistics

Health Care Quality

Proteomics

Neuroscience

Nanostructures

Translational Cancer Therapeutics

Vehicle Electronic Systems Integration

Optical Materials

Cyber-Institute

CLINICAL EFFECTIVENESS & PATIENT SAFETY

Tourism & Economic Development

Opto-electronics

Renewable Fuel Cells

Tissue Systems Characterization

Automotive Systems Integration

Strategic Approaches to Electricity Production from Coal

Marine Genomics

Hydrogen & Fuel Cell Economy

Stroke

Renal Disease Biomarkers

Nuclear Science and Energy

ADVANCED FIBER-BASED MATERIALS

Polymer Nanocomposites

Cancer Stem Cell Biology & Therapy

SOLID OXIDE FUEL CELLS

Urban Ecology & Restoration

Health Facilities Design & Testing

Childhood Neurotherapeutics

LIPIDOMICS

AUTOMOTIVE MANUFACTURING

"These endowed professorships should be used to recruit and maintain leading scientists and engineers at the senior research universities of South Carolina for the purposes of developing and leveraging the research capabilities of the universities for the creation of well-paying jobs and enhanced economic opportunities in knowledge-based industries for all South Carolinians."

Regenerative Medicine

SENIORSMART™

SOUTH CAROLINA RESEARCH CENTERS OF ECONOMIC EXCELLENCE ACT

Tobacco-Related Malignancy

Nuclear Science Strategies

Automotive Design & Development

Vision Science

CoEE Program Basic Facts

USC's Horizon Research Facility

In 2002, the S.C. General Assembly passed the Research Centers of Economic Excellence Act. Since 2003, the General Assembly has appropriated $180 million from the Education Lottery to establish unique Centers of Economic Excellence (CoEE) at South Carolina's three senior research institutions: Clemson University, the University of South Carolina and the Medical University of South Carolina.

Each CoEE specializes in knowledge-based research in fields such as engineering, nanotechnology, biomedicine, cancer research, energy science, and environmental science. The world-class scientists hired to be CoEE endowed chairs secure private sector funding and federal grants and over time increase the state's knowledge base and stimulate the economy.

The RCEE Act also created the CoEE Review Board, which provides program oversight. The Board is composed of 11 members appointed by the Governor, Senate President, Speaker of the House, Senate Finance Chair, and House Ways & Means Chair. The three research university presidents serve as non-voting members. Staff and operational support are provided by the S.C. Commission on Higher Education, which also approves the program's operational budget.

Clemson's Intelligent River Project

How the CoEE Program Works

The CoEE Review Board oversees a competitive, annual process whereby Centers of Economic Excellence and supporting endowed chairs are proposed by the research institutions (individually and collaboratively). The annual proposal cycle includes a three-tier review process with two rigorous scientific evaluations (a technical review and an onsite review), followed by the Review Board's analysis of the review findings and a formal vote on proposals.

Upon the awarding of a CoEE, an institution has 18 months in which to solicit dollar-for-dollar, non-state (private and federal) pledges to match the state award total (between $2 million and $5 million). These non-state matching pledges must be "realized" (in hand) within 78 months of the award date. State CoEE funds may only be drawn against realized non-state pledges.

The entire state award, plus no less than 30% of the non-state match, is placed into endowment for each CoEE. The endowment may pay the salaries or salary supplements of the world-class scientists (endowed chairs) recruited to lead each CoEE and may also fund the purchase of equipment, laboratory construction, other faculty and research assistants.

From 2003-2009, the CoEE Review Board approved 45 Centers and 79 CoEE endowed chair positions. 22 CoEE Chairs have been appointed to date.

SOUTH CAROLINA CoEE

Clemson University
12 CoEEs
15 CoEE Chairs

University of South Carolina
15 CoEEs
26 CoEE Chairs

Medical University of South Carolina
18 CoEEs
38 CoEE Chairs

Economic Impact of the CoEE Program

State Investment:
$183.6 million

Non-State Matching Pledges
$145 million

Extramural Research Grants
(above matching requirement)
$120 million

New SC Jobs
3,200 *

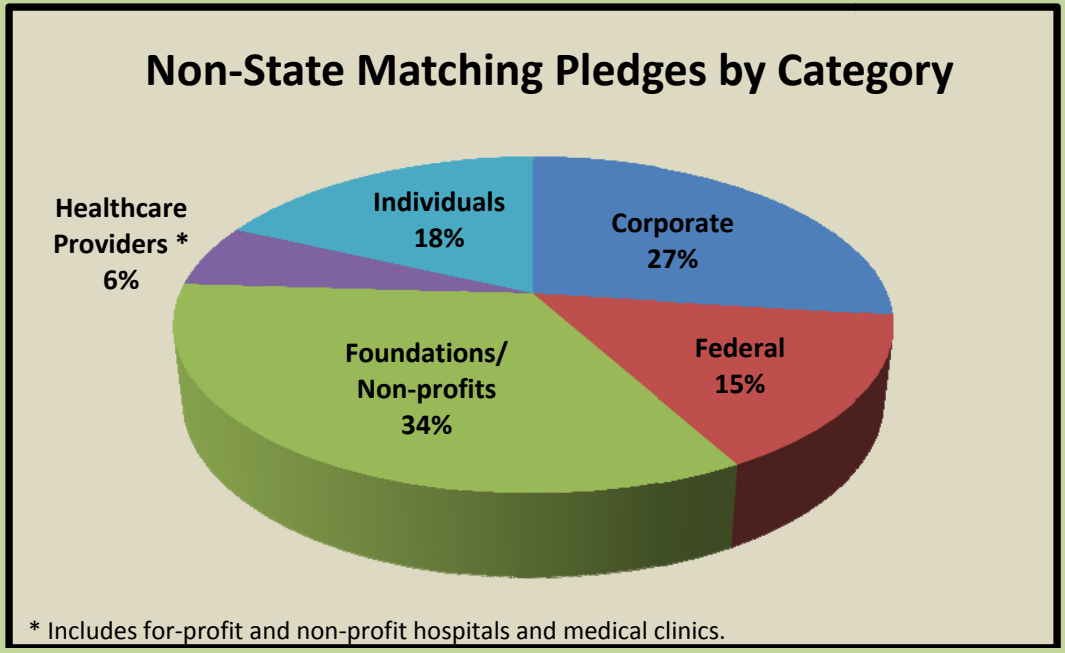
[* Data assistance provided by the USC Darla Moore School of Business.
See following page for a breakdown of this figure.]

State Investment: $183.6 million

Since 2003, the S.C. General Assembly has invested $180 million in State Education Lottery earnings to fund CoEEs. Between FYs 2003 and 2008, the General Assembly appropriated $30 million annually to the CoEE Program. No funding was provided in FY 2009 and 2010. By statute, the CoEE Review Board is allowed to use accrued program interest to fund additional CoEEs. At the end of FY 2009, the CoEE Review Board had used $3.6 million of program interest for this purpose.

Non-State Matching Pledges: $145 million

By statute, federal grants and in-kind contributions may be claimed as part of the dollar-for-dollar non-state matching requirement. However, the chart below demonstrates that ***federal funds account for only 15% of total non-state matching pledges***. In-kind contributions (from individuals and corporations) account for only 2% of total non-state matching pledges.



New SC Jobs: 3,200

One of the principal mandates of the CoEE Program is the creation of well-paying jobs in South Carolina. To date, the CoEE Program has resulted in 1,224 high-paying, knowledge-based economy jobs. This figure includes CoEE personnel, start-up company employees and direct corporate relocations. According to the USC Darla Moore School of Business, another 2,000 new jobs have likely resulted from the impact of $120 million in extramural research funding (grant funding over and above the non-state matching requirement) brought into the South Carolina economy by CoEE chairs and their research teams.

CoEE Investor Spotlight

In 2009, global medical technology company Smith & Nephew announced a $5 million partnership investment with the CoEE in Rehabilitation and Reconstruction Sciences at USC. **[See CoEE profile on page 61.]** This CoEE brings together USC researchers, the Orthopedic Research Foundation of the Carolinas (ORFC), and the Smith & Nephew Biologics & Spine division to research and develop cutting-edge orthopedic therapies and technologies.

Why would a leading global orthopedics company invest in South Carolina research? Ken Reali, a Smith & Nephew executive, shares about his company's interest in the CoEE Program and why he thinks it provides a unique opportunity to investigate new technologies and therapies.

Ken Reali, Smith & Nephew Biologics & Spine Senior VP and General Manager

Why did Smith & Nephew invest in the CoEE Program?

Reali: No other state had a program that could match the benefits available through the CoEE Program.

What we found in South Carolina provided a unique opportunity for collaboration between our company, a research university, and the ORFC, with a network of associated orthopedic clinics. This collaboration draws on the expertise of world-class academic, clinical, and commercial partners to develop technologies to help future generations of patients.

Advanced, biologic therapies are a new field for Smith & Nephew and one that requires strong partnerships to maximize the opportunities for success. The fact that the state matched our investment dollar-for-dollar was a powerful incentive.

How do you believe your company will benefit from this investment?

Reali: We are confident our company will benefit in multiple ways. Innovative therapies can be initiated by USC public health and biomedical engineering research partners, developed and advanced with the support of Smith & Nephew, then studied carefully by the ORFC and its associated clinics. With the help of our partners, we will be able to evaluate new product and treatment performance and assess the potential they hold for helping patients regain their lives.

The CoEE Program also provides a cost-effective way to expand the breadth and depth of our research. We want to develop the right technologies in a way that adds value and is beneficial to patients and clinicians.

What do you see as the potential long-term advantages of investing in the CoEE Program?

Reali: Long-term, we hope to see innovative and cost-effective technologies developed for commercialization. Our aim is to accomplish translational research, taking products from bench to bedside. Through this CoEE, we will be able to consult a broad range of clinicians as well as patients to better understand their needs and problems and to determine the right technology to help them meet those needs. The overarching theme of our involvement is helping people improve their lives. We believe the work done in the new Center will add value for our business, our customers and their patients.

THE PAYOFF OF KNOWLEDGE-BASED RESEARCH AND DEVELOPMENT

The economic dividends of academic research result from years of laboratory research and clinical trials. The payoff can be remarkable. The development of the blood thinner Warfarin and synthetic Vitamin D has resulted in millions of licensing dollars for the Wisconsin economy. The same is true of the cancer drug Taxol for Florida. Below are selections from a 2005 press release from the landmark licensing of the HIV drug Emtriva at Emory University in Georgia:

GILEAD SCIENCES AND ROYALTY PHARMA ANNOUNCE $525 MILLION AGREEMENT WITH EMORY UNIVERSITY

Gilead Sciences, Inc. and Royalty Pharma today announced that the companies have entered into an agreement with Emory University providing for the purchase of the royalty interest owed to Emory for emtricitabine, also known as Emtriva®. Under the terms of the agreement, Gilead and Royalty Pharma will make a one-time cash payment of $525 million to Emory in exchange for elimination of the emtricitabine royalties due to Emory on worldwide net sales of the product. The transaction, subject to customary closing conditions, is expected to close on or before July 29, 2005.

The University's share of the transaction will be reinvested in Emory's research mission following the terms of the Bayh-Dole Act passed by Congress in 1980 to encourage commercialization of research by universities.

"We feel privileged and humbled to receive such extraordinary recognition for the value of our intellectual property," said Emory University President Dr. James Wagner. "These dividends will be plowed back into our mission of research and discovery for the benefit of our state, our nation and the world, in accordance with the priorities in our University-wide strategic plan."

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"[T]here are those who say we cannot afford to invest in science. That support for research is somehow a luxury at a moment defined by necessities. Science is more essential for our prosperity, our security, our health, our environment, and our quality of life than ever.

It was basic research in the photo-electric effect that would one day lead to solar panels. It was basic research in physics that would eventually produce the CAT scan. The calculations of today's GPS satellites are based on equations Einstein put to paper more than a century ago.

The renewed commitment of our nation will not be driven by government investment alone. It is a commitment that extends from the laboratory to the marketplace."

President Barack Obama
to the National Academy of Sciences
April 27, 2009

CoEE Program Technology Transfer 2003-2009

CoEE Name	CoEE Award Date	Chairs Approved	Chairs Hired	Center Expenditures *	Invention Disclosures
Automotive Systems Integration	2002-03	1	1	$12,927,737	0
Automotive Manufacturing	2002-03	1	1	$14,996,001	3
Nanostructures	2002-03	1	1	$7,582,435	0
Brain Imaging	2002-03	3	1	$5,711,308	7
Proteomics	2002-03	1		$1,287,237	5
Neuroscience	2002-03	3	1	$3,617,308	0
Marine Genomics	2002-03	2		$8,140,726	6
Automotive Design & Development	2003-04	1	1	$13,748,190	6
Electronics Systems Integration	2003-04	1	1	$12,543,862	4
Photonic Materials	2003-04	1		$18,310,144	30
Polymer Nanocomposites	2003-04	1	1	$2,326,189	5
Hydrogen & Fuel Cell Economy	2003-04	2		$5,360,994	8
Regenerative Medicine	2003-04	3	2	$3,382,957	0
Translational Cancer Therapeutics	2003-04	2	1	$3,775,990	4
Renewable Fuel Cells for Fuel Cell Economy	2004-05	1		$2,239,563	12
Tourism & Economic Development	2004-05	1		$14,852	0
Gastrointestinal Cancer Diagnostics	2004-05	2	1	$257,922	7
Cancer Drug Discovery	2004-05	4	2	$7,380,905	7
Vision Science	2004-05	3		$1,405,760	0
Supply Chain Optimization & Logistics	2005-06	1		$491,519	1
Urban Ecology & Restoration	2005-06	1		$4,095,711	2
Advanced Fiber-Based Materials	2005-06	1		$84,722	17
Solid Oxide Fuel Cells	2005-06	1	1	$3,684,813	1
Childhood Neurotherapeutics	2005-06	3		$0	2
Molecular Proteomics in CV Disease & Prevention	2005-06	2		$206,767	5
Clinical Effectiveness & Patient Safety	2005-06	3	3	$2,794,819	0
Health Facilities Design and Testing	2006-07	2		$255,138	0
Rehabilitation and Reconstruction Sciences	2006-07	1		$0	0
Strategic Appr. to Electricity Prod. from Coal	2006-07	1		$96,714	0
Healthcare Quality	2006-07	2	2	$3,900,717	0
SeniorSMART™ Center	2006-07	3		$19,494	0
Tobacco-Related Malignancy	2006-07	2		$21,343	0
Stroke	2006-07	3	2	$1,650,971	0
Optoelectronics	2007-08	1		$0	0
Cyber-Institute	2007-08	1		$690,476	0
Nanoenvironmental Research and Risk Assessment	2007-08	1		$0	0
Nuclear Science & Energy	2007-08	1		$0	0
Renal Disease Biomarker	2007-08	2		$2,714	1
Cancer Stem Cell Biology	2007-08	2		$6,230	0
Advanced Tissue Biofabrication	2007-08	3		$0	0
Cancer Disparities	2007-08	3		$32,284	0
Medication Safety and Efficacy	2007-08	1		$0	0
Nuclear Science Strategies	2008-09	1		$0	0
Lipidomics, Pathobiology and Therapy	2008-09	2		$0	3
Tissue Systems Characterization	2008-09	1		$0	0
2009 TOTALS		**79**	**22**	**$143,044,512.00**	**136**
2008 TOTALS		**71**	**15**	**$115,208,599.36**	**110**

* Column represents all expenditures, including institutional investment.

Provisional U.S. Patents Applications	U.S. Patent Applications	U.S. Patents Issued	Int'l. Patent Applications	Int'l. Patents Issued	Active Licenses	Licenses & Options Executed	License Income	Start-Up Companies
0	0	0	0	0	0	0		0
0	0	0	0	0	0	0		0
0	0	0	0	0	0	0		0
3	7	0	1	0	0	0		0
2	3	1	0	0	0	0		0
0	0	0	0	0	0	0		1
6	1	0	5	0	1	3	$175,025	0
0	3	0	0	0	0	0		0
2	3	0	0	0	0	0		0
8	20	10	0	0	7	5	$83,148	2
4	3	0	0	0	1	1	$1,500	0
2	2	0	0	0	1	1		1
0	0	0	0	0	0	0		1
1	0	0	0	0	0	0		0
10	4	0	0	0	0	0		1
0	0	0	0	0	0	0		0
4	3	0	0	0	0	0		0
4	1	0	1	0	2	2	$16,000	2
0	0	0	0	0	0	0		0
0	0	0	0	0	0	0		0
0	0	0	0	0	0	0		0
6	8	1	1	1	5	4	$60,000	1
1	0	0	0	0	0	0		1
2	3	0	9	0	0	1	$125,000	1
3	2	0	5	0	1	1	$125,000	0
0	0	0	0	0	0	0		0
0	0	0	0	0	0	0		0
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0	0	0	0	0	0	0		0
0	0	0	0	0	0	0		0
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58	**63**	**12**	**22**	**1**	**18**	**18**	**$585,673**	**11**
52	**49**	**7**	**27**	**1**	**10**	**13**		__

COMMERCIALIZING DISCOVERY

TECHNOLOGY TRANSFER converts the groundbreaking scientific discoveries of CoEE researchers into marketable products and services and spurs the creation of high-paying R&D jobs to support the commercial development of the technology and skilled manufacturing jobs for workers who make and sell the product or provide the service.

Discovery and Patent

When a CoEE researcher makes a scientific **DISCOVERY** (**INVENTION DISCLOSURE**) that has commercial possibilities, the university files for a **PATENT**—a set of exclusive rights granted by the U.S. government to an inventor (or assignee) for a certain period of time. USC, MUSC, and Clemson each have a technology transfer office to handle the patent process, as well as the marketing and licensing of scientific discoveries (also called **"INTELLECTUAL PROPERTY"**) made by CoEE chairs.

A patent allows an invention owner to bring a product …

[see next page]

"Commercializing Discovery"

[continued from previous page]

Dr. Yusuf Hannun, principal investigator of the Lipidomics COEE and student, Che Sutton, conduct a project on the regulation of cell growth by lipids.

… to market exclusively. Often with high-tech products, this "exclusivity" provides enough financial return to justify the investment required to place a product on the market. In addition to U.S. patents, institutions seek international patents that secure invention rights abroad.

CoEE endowed chairs and their research teams have applied for 143 U.S. and international patents and provisional patents for their discoveries. They have received a total of 13 U.S. and International patents.

License and Marketing

With a **LICENSE**, a university grants the right to practice the patentable invention to a commercial entity, which then invests the resources required to place a product on the market. The license is acquired by companies or individuals who pay to use the intellectual property to manufacture a product or provide a service and then market that product or service to a specific or broader market.

Often, the parties who purchase a license start a new company based on the newly developed product or service. This commercial enterprise is called a **START-UP COMPANY**. [See opposite page for a CoEE Program start-up company profile.] Other times, an existing company will license the intellectual property and produce the new product or service, which leads to a robust relationship with the university and region. These are two ways technology transfer leads to economic development.

Selling licenses for the use of intellectual property can be lucrative for universities. According to the Milken Institute, for every $1 a university invests in technology transfer, the university receives on average more than $6 in **LICENSING INCOME** in return. While the CoEE Program is relatively young in terms of intellectual property generation, USC, MUSC and Clemson combined already have 18 active licenses based on intellectual property from the CoEE research. The combined number of licenses and options executed from this research is 13, and the universities have received more than a half-million dollars in license income to date.

FirstString Research
CEO Dr. Gautam Ghatnekar
and Executive Chairman Jim McNab

CoEE Program Start-up Company Profile

Regenerative Medicine CoEE Start-up: Time no Longer Needed to Heal all Wounds

Several years ago, two researchers at MUSC stumbled upon a technology that seemed to help wounds heal faster. In fact, their discovery not only speeds healing but significantly reduces and prevents scarring.

After extensive research efforts, Drs. Gautam Ghatnekar and Robert Gourdie (a senior personnel MUSC faculty member in the Regenerative Medicine CoEE), licensed the technology from MUSC and then established FirstString Research, a start-up biotechnology company.

FirstString's lead commercial product is a topical, peptide-based gel that can keep the body from scarring and promotes regeneration of damaged tissue, particularly if application is begun within 24 hours of injury. "Our technology fundamentally shifts the body's balance from healing by scarring to healing by regeneration," says Dr. Ghatnekar, President and CEO of FirstString.

"The product is so powerful," says Jim McNab, executive chairman of FirstString's board. McNab, who has been a leader in several drug discovery and medical device companies, is active within FirstString on a day-to-day basis.

This peptide-based "wound repair gel" can be used to address scarring on the skin surface. With a different formulation, such as an aerosol or liquid, the gel can tackle more serious internal scarring. Preclinical tests on all these indications have yielded an "impressive suite of data," according to McNab. "Our technology could be used for any number of injuries: heart attacks, spinal cord injuries, hip implants, stents, and age-related macular degeneration, to name a few."

FirstString's management team has successfully raised enough capital to take the company through the completion of Phase I human safety trials. Phase 2 trials are scheduled to begin toward the end of 2009 or early 2010.

The jobs the company hopes to create pay an average wage of $80,000 a year—more than three times the average salary in South Carolina. If clinical testing of the wound repair gel is successful, the company will add manufacturing and packaging facilities to its operation, which will mean more jobs and a bigger contribution toward raising the state's standard of living.

"Our hope is to keep the company in South Carolina," says McNab. "Once we begin manufacturing, we want to keep our manufacturing operation in state. Our goal is to have a large-scale plant which could create thousands of jobs."

Other Economic Benefits of the CoEE Program

Industry Conferences

Formula One Racing Car at the 2009 NHA Conference

Columbia hosted the 2009 National Hydrogen Association Conference and Hydrogen Expo, bolstering South Carolina's favorable position in the hydrogen industry. With 700 registered attendees and 2,000 public visitors, the conference nearly doubled attendance from past conferences.

The CoEE Program was an integral part of this event. CoEE Chairs, researchers and students from the Hydrogen and Fuel Cell CoEE and the Renewable Fuels CoEE participated and presented lectures.

Federal Designations

In March 2009, MUSC's Hollings Cancer Center (HCC) received a National Cancer Center Designation by the National Cancer Institute (NCI), a revered distinction only assigned to top-ranked U.S. cancer centers such as the Mayo Clinic.

The work of several CoEE chairs, including HCC Associate Director of Clinical Investigations Dr. Melanie Thomas, was a critical factor in NCI's decision.

MUSC also received $7.3 million towards cancer research. A study conducted by the MUSC Center for Health Economics and Policy Studies predicts the National Cancer Center designation will add $31 to $38 million to the Charleston economy over the next five years.

MUSC receives National Cancer Center Designation by the National Cancer Institute

Research Grants

In FY 2009, CoEE chairs and their research teams received $35 million in extramural research funding from private and federal sources.

CoEE Chair Dr. Kenneth Reifsnider

The largest research grant in the history of USC, $12.5 million, was awarded to CoEE chair Dr. Kenneth Reifsnider of the Solid Oxide Fuel Cells CoEE (USC) and to his team of mechanical and chemical engineers.

The grant will create one of 31 national Energy Frontier Research Centers (EFRC) sponsored by the U.S. Department of Energy.

Corporate Relocations

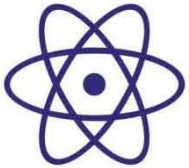
In FY 2009, **American Titanium Works (ATW)** announced that, due in part to the research synergies of the CoEE Program at Clemson University, it will build a world-class titanium mini-mill in Laurens County. The company will invest an estimated **$422 million** and plans to employ **320 people** at its new Laurens County facility. ATW also announced that it will establish its applications development and engineering technical center at the Clemson University International Center for Automotive Research (CU-ICAR) campus. This technology center will create **40 additional engineering jobs** that will specialize in prototype development and fabrication techniques for multiple industry sectors.

Clemson University Centers of Economic Excellence

BIOTECHNOLOGY AND BIOMEDICAL SCIENCES

- Health Facilities Design and Testing
- Tissue Systems Characterization

ADVANCED MATERIALS



- Optical Materials/Photonics
- Advanced Fiber-based Materials
- Optoelectronics

SUSTAINABLE ENVIRONMENT

- Urban Ecology and Restoration

AUTOMOTIVE AND TRANSPORTATION TECHNOLOGY

- Automotive Manufacturing
- Automotive Systems Integration
- Automotive Design and Development
- Vehicle Electronic Systems Integration
- Supply Chain Optimization and Logistics

CLEMSON UNIVERSITY

CoEE ENDOWED CHAIRS BY EMPHASIS AREAS, 2003-2009

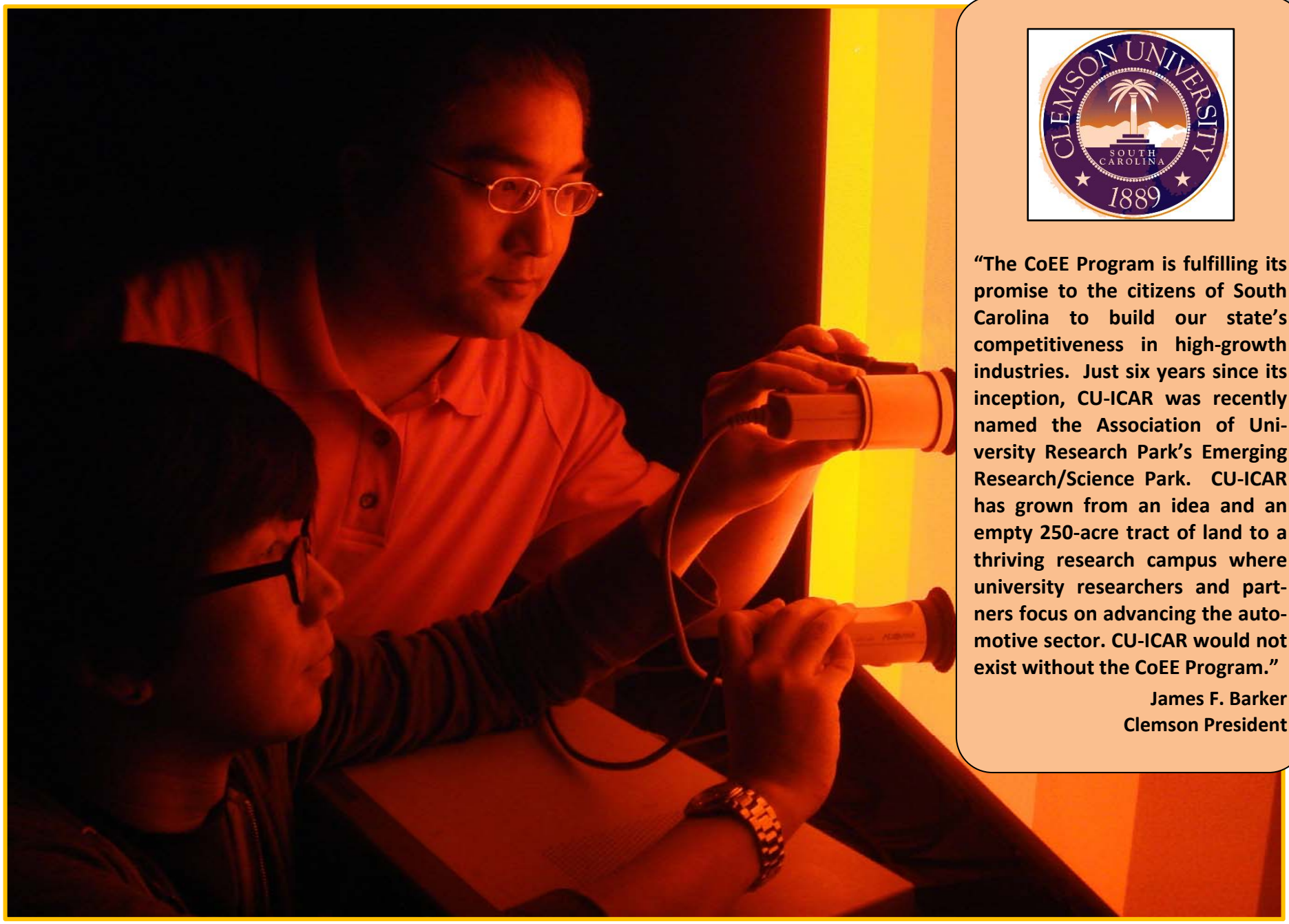
LEADERSHIP AND ENTREPRENEURSHIP

GENERAL EDUCATION

FAMILY AND COMMUNITY LIVING

INFORMATION AND COMMUNICATION TECHNOLOGY

- Cyber-Institute



"The CoEE Program is fulfilling its promise to the citizens of South Carolina to build our state's competitiveness in high-growth industries. Just six years since its inception, CU-ICAR was recently named the Association of University Research Park's Emerging Research/Science Park. CU-ICAR has grown from an idea and an empty 250-acre tract of land to a thriving research campus where university researchers and partners focus on advancing the automotive sector. CU-ICAR would not exist without the CoEE Program."

James F. Barker
Clemson President

AUTOMOTIVE AND TRANSPORTATION TECHNOLOGY

CLEMSON UNIVERSITY

SOUTH CAROLINA CoEE

"South Carolina has numerous resources to meet our tech center's needs, including a deep pool of engineering talent and extensive innovation occurring throughout the state. We are thrilled to be coming to an area where university researchers are actively involved with the industrial community."

Thomas Sax
CEO, American Titanium Works

CU-ICAR Carroll A. Campbell, Jr. Graduate Engineering Center

"I've seen a lot of the parks that universities have put together, and I've never seen anything like this that has such a unified vision and ability to execute that vision. It's really, really impressive."

Nabil Elkouh
CTO, American Titanium Works

CU-ICAR

TOMORROW'S ENGINEER TODAY

Clemson University International Center for Automotive Research (CU-ICAR)

CU-ICAR, a worldwide automotive/motor sports research and development campus, has four CoEE Endowed Chairs (Automotive Manufacturing, Automotive Systems Integration, Automotive Design & Development, and Vehicle Electronic Systems Integration) and more than $220 million in public and private investment to date, including major corporate partnerships with BMW, Michelin and Timken. The Carroll A. Campbell, Jr. Graduate Engineering Center on the CU-ICAR campus houses all four Clemson CoEE automotive endowed chairs and their research teams.

In 2007, CU-ICAR faculty completed the Automotive Engineering graduate school curriculum, including the first Automotive Engineering Ph.D. in the nation. The program graduated its first class in August 2009. Thus far, the program has doubled in size every year; the program currently includes students from the U.S. and countries such as China, India, Italy, Germany, and Malaysia.

In 2009, CU-ICAR's Automotive Engineering Program was greatly aided by corporate equipment donations. Donations included a $600,000 Cylinder Pressure Indicating System from AVL, a leading engine research company. Other corporate donors included Bosch, ROTEC (Munich), and A& D Technologies. In December 2008, CU-ICAR partnered with Hexagon Metrology and Innovmetric, Inc., which resulted in the acquisition of a Romer Platinum Measurement Arm and Laser Scanning Head for support of research projects initiated by BMW, Michelin and Timken.

Companies are recognizing the strategy of being in close proximity to the amazing research endeavors at CU-ICAR. American Titanium Works (ATW) announced relocation plans to the Greenville area. The company will invest $422 million in the Upstate, including a 320-person manufacturing plant in Laurens County and an applications development and engineering technical center on the CU-ICAR campus.

Professor Laine Mears of the Automotive Manufacturing CoEE works on the 6-axis KUKA robot donated to CU-ICAR by Greenville-based Automation Engineering Corporation.

Automotive Manufacturing

Award Date: 2003 **Award Amount**: $5 million

BMW CoEE Endowed Chair in Automotive Manufacturing: Dr. Thomas Kurfess

This CoEE is developing novel micro-electromechanical systems technologies for manufacturing and improving the efficiency of manufacturing large, complex objects.

This CoEE has contacted and/or is in discussion to develop private sector partnerships with such major companies as GM, IBM, Toyota, Honda, Daimler-Chrysler, Hewlett-Packard, Nissan, and Bosch. In 2009, the Automotive Manufacturing CoEE Team hosted two major conferences at the research campus which introduced more than 300 researchers and engineers to CU-ICAR. Scientific discoveries include the development of an apparatus that simulates the effects of contaminants, soil, and lubrication on rotating machinery such as gears, wheels, and fan blades. Since inception, this CoEE has received over $1 million in federal and private research funding.

Automotive Systems Integration

Award Date: 2003 **Award Amount**: $5 million

BMW Chair in Automotive Systems Integration: Dr. Paul Venhovens

Leaders at BMW and their supplier companies have noted an industry-wide need for systems integration engineers. (Systems integration is the testing of vehicle systems and their components to ensure efficient and safe operation.) In order to serve this critical need, BMW committed itself as the major non-state partner for this endowed chair, which serves as the linchpin of the CU-ICAR faculty positions.

In 2009, CoEE Chair Dr. Paul Venhovens and his team formulated the four focus areas of the CoEE: sustainable mobility, safer mobility, diagnostics and prognostics, and vehicle architectures and development tools. Venhovens has also co-created an exciting innovative educational concept called Deep Orange. The project allows CU-ICAR graduate students to create a vehicle from scratch over the course of two years, from blank sheet to market aspects to review of quality-related elements to a physical prototype launch, validation and "evidence book."

AUTOMOTIVE AND TRANSPORTATION TECHNOLOGY

[CONT'D]

CLEMSON UNIVERSITY

SOUTH CAROLINA CoEE

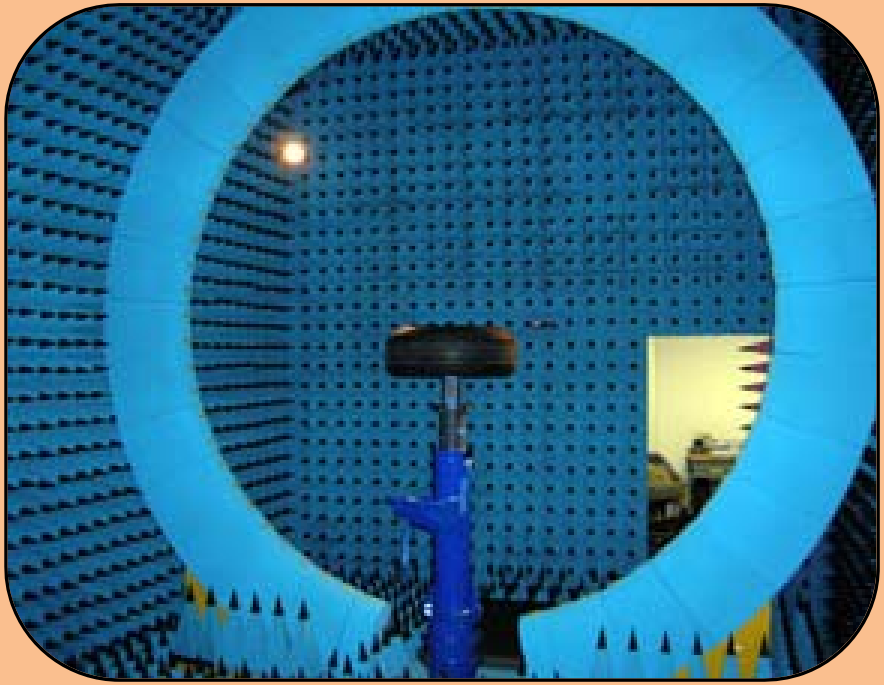
Vehicle Electronic Systems Integration

Award Date: 2004 **Award Amount**: $3 million

Michelin CoEE Endowed Chair in Vehicle Electronic Systems Integration: Dr. Todd Hubing

This CoEE researches vehicle electronics, a complex field where components such as software, telematics, information and communication systems, electronics, mechatronics, and sensors must be integrated in a well-balanced way to create attractive, stable products.

The CoEE has created two consortia: (1) the Clemson Vehicular Electronics Consortium which provides companies access to the automotive research at CU-ICAR, and (2) the Clemson Advanced Capacitor Consortium, which held its organizational meeting in January 2009, drawing representatives from such corporations as Kemet, the University of Rome, Hitachi, and Dielectric Laboratories. This CoEE has received more than $300,000 in research funding from federal and private sources.



Vehicle Electronic Systems Integration Tire Antennae Project.

Students in the Vehicle Electronic Systems Integration laboratory.

Automotive Design & Development

Award Date: **2003** Award Amount: **$5 million**

Timken Endowed Chair in Automotive Design and Development: Dr. John Ziegert

This CoEE researches and advances the fields of vehicular design and development, methodologies, and design tools. Ziegert and his team design automotive instruments and machines used in high-precision measurement and manufacturing. They also develop friction management and power transmission solutions that will improve manufacturing processes for a variety of industry sectors.

Non-state funding has been secured with the Timken Company, which provides automotive industry products and solutions based on friction management and power transmission. In September 2006, Timken opened its Greenville Technology Center on the CU-ICAR campus, which houses 200 employees and Timken's product development activities for automotive applications and its worldwide corporate center of excellence for dimensional and surface metrology and manufacturing process development. This CoEE also researches chassis fabrication for Dale Earnhardt, Inc. and X-5 assembly issues for BMW. This CoEE has received over $650,000 in grant funding from federal and private sources.

Supply Chain Optimization & Logistics

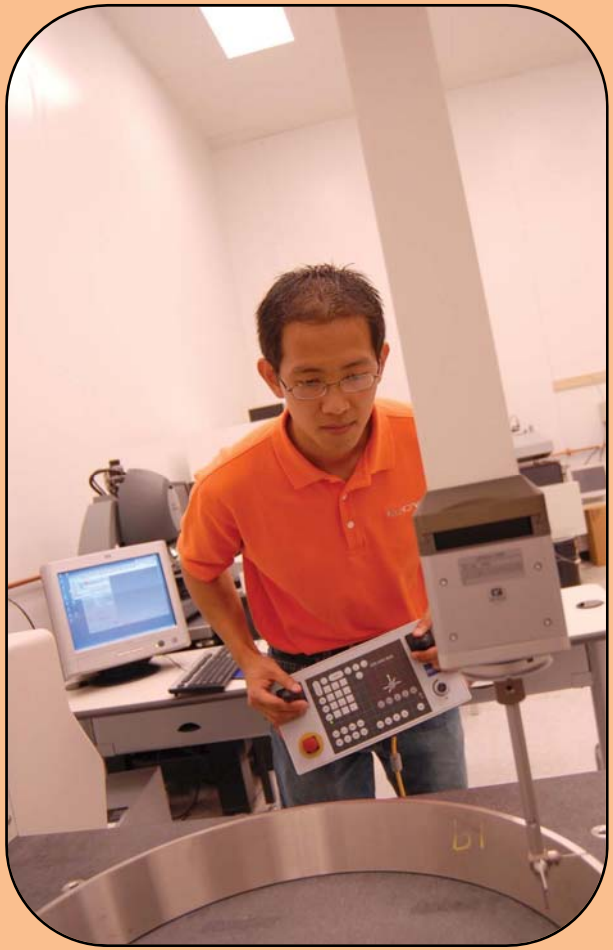
[not a CU-ICAR Automotive CoEE]

Award Date: **2005** Award Amount: **$2 million**

Chair: Clemson is recruiting the Fluor Chair in Supply Chain Optimization & Logistics.

This CoEE is a component of a larger initiative, the Clemson Institute for Supply Chain Optimization and Logistics (CISCOL). Research at this CoEE centers on supply chain modeling, material handling, logistics, planning systems and distribution. The primary goals include: (a) conducting interdisciplinary research of multifaceted supply chain problems; (b) assisting in economic development by providing industries with access to Clemson's resources and expertise in supply chain activities; (c) delivering tangible products and services in the area of supply chain optimization and logistics; and (d) conducting educational activities supporting technology transfer.

Fluor Corporation is a full non-state partner for this CoEE. This CoEE has received sponsored research funding from Norfolk Southern, Michelin, Lockheed Martin, Aerospace Engineering, IntelliTrans Solution, SPAWAR, Bosch, General Electric, BMW, Taylor Made, Spartanburg Regional Healthcare System, and TransSolution. To date, the CoEE has received over $1 million in federal and private research funding.



Some examples of current projects for the **Supply Chain Optimization & Logistics CoEE** include a scrap efficiency assessment with Fabri-Kal of Piedmont, SC; a material and part flow project with St. Jude Medical of Liberty, SC; and a changeover and material movement project with Schneider Electric/Square D of Seneca, SC.

Health Facilities Design & Testing

Award Date: 2007 **Award Amount**: $5 million **Collaborating Institution:** MUSC

Clemson Chair: Clemson is recruiting the CoEE Chair in Architecture and Health Research.

MUSC Chair: MUSC is recruiting the CoEE Chair in Human Factors Medical Research.

The purpose of the CoEE is to expand and disseminate knowledge on how health facility design impacts health and healthcare delivery and how to create architectural settings that better support the health and well-being of patients and staff. Through interdisciplinary research, this CoEE addresses the relationship between physical healthcare environments and the following four areas: health and clinical outcomes; patient, family and staff satisfaction; operational efficiencies; and the ability to accommodate change.

This CoEE has been awarded a U.S. Department of Defense subcontract entitled "Patient Room of the Future." The first two contract phases provided over $790,000 in funding. Project partners include Spartanburg Regional Hospital System, Rensselaer Polytechnic Institute, and IoA Healthcare Furniture. The physical prototype room was completed in July 2008, and analysis has begun on the impact of nature views on health, headwall design performance, and lighting design concepts. The project was highlighted at the 2009 International Conference on the Design, Planning and Construction of Healthcare Facilities. The CoEE's two principal investigators are recipients of "Twenty Who Are Making a Difference" by *Healthcare Design* magazine.

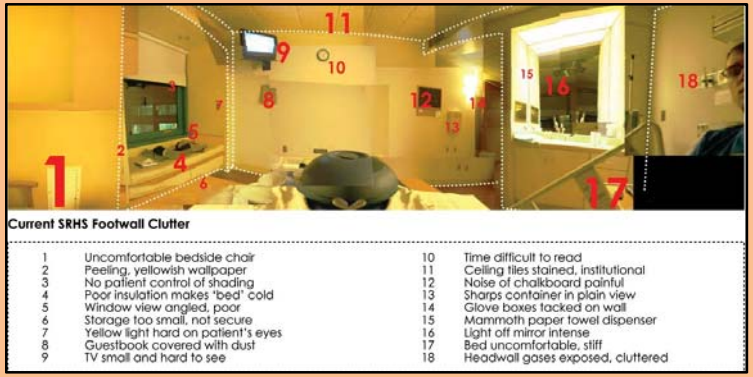


Figure A.

Figure B.

For the Patient Room Prototype Project, faculty and students spent nights in actual hospital rooms simulating patient life. One observation was the cluttered footwall **[Figure A]**. The wall was unsightly with exposed medical equipment; also, observers found the television screen and the clock too small to see. Other uncomfortable room features included harsh lighting, poor window visibility, and uncomfortable guest seating. With a new room design **[Figure B]**, critical medical equipment is out of sight but still accessible. Lighting and temperature are more easily controlled by the patient, and the footwall uses flatscreen technology to display virtual windows, television entertainment, medical charts, and video conferencing.

Tissue Systems Characterization

Award Date: 2009 **Award Amount**: $3 million

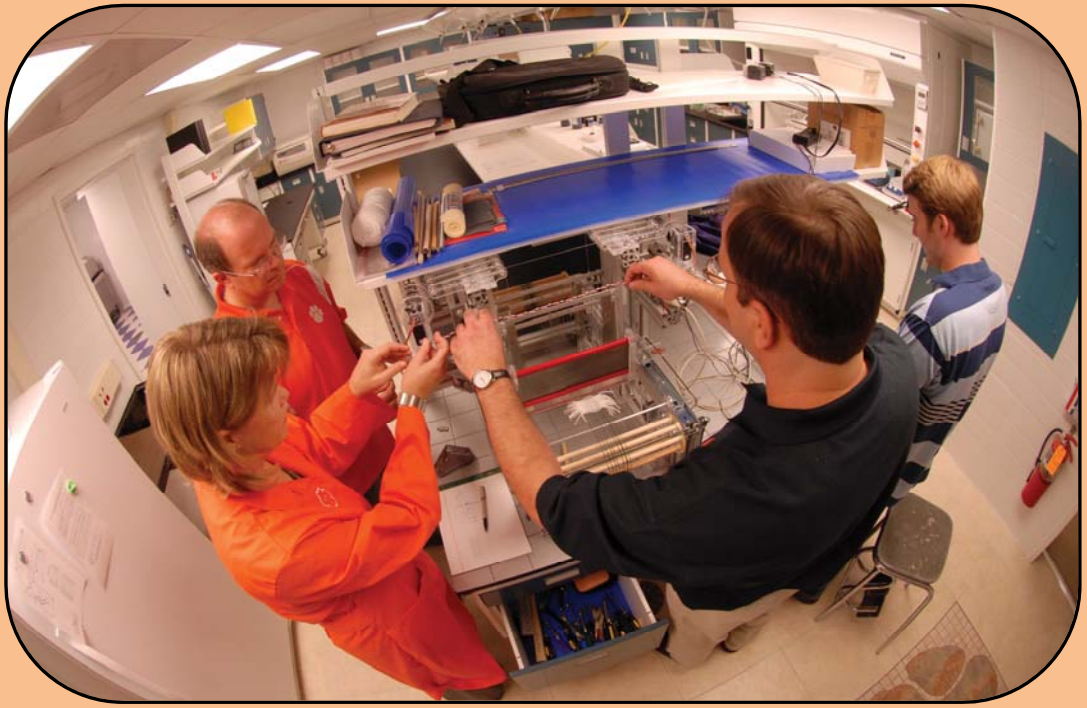
Chair: Clemson is recruiting the COEE CHAIR IN TISSUE SYSTEMS CHARACTERIZATION.

Part of a larger Clemson initiative, the Institute for Biological Interfaces of Engineering (IBIOE), this CoEE expands on Clemson's expertise in tissue engineering and biomaterials to provide alternatives to animal testing. This CoEE also allows Clemson researchers to further explore new tissue-based technologies that could serve as diagnostic or therapeutic products.

The convergence of biology and engineering is currently a major focus of industry and governmental funding. The CoEE endowed chair will lead the cell biology component of IBIOE, creating a strategic research program for the analysis of cell mechanisms and behaviors, resulting in three-dimensional tissue systems.

INSTITUTE FOR BIOLOGICAL INTERFACES OF ENGINEERING

SOUTH CAROLINA CoEE



Clemson Electrical and Computer Engineering IBIOE faculty members Dr. Timothy Burg (top left) and Dr. Richard Groff (second from right), and IBIOE Director and CoEE principal investigator Dr. Karen Burg (bottom left), with a benchtop loom. Based on textile industry weaving technology, the loom is used in the IBIOE Tissue Systems Characterization CoEE to create scaffolding for tissue repair. See www.clemson.edu/centers-institutes/ibioe/ .

Urban Ecology & Restoration

Award Date: 2005 **Award Amount**: $2 million

Chair: Clemson is recruiting the CoEE Chair in Urban Ecology and Restoration.

This CoEE supports the growth of the state's environmental industry and attracts world-renowned faculty in restoration development. This CoEE is unique for its interdisciplinary, integrative approach to the restoration of historic, ecological and urban infra-structure resources through the integration of basic science, engineering, and urban planning.

The CoEE was instrumental in Clemson's award of a 2008 Center of Excellence in Watershed Management by the U.S. Environmental Protection Agency. This is the third such designated center in the Southeast and the first center in the nation focused on using remotely-sensed monitoring data. The CoEE, in conjunction with Clemson's Restoration Institute, sponsored the first annual South Carolina Water Resources Conference in October 2008, which was attended by over 350 participants. Of the 350 attendees, roughly one-third represented commercial or consultant entities. The CoEE has initiated four multidisciplinary urban ecology projects in the state: (a) restoration of a degraded urban stream in Aiken; (b) a study project for the City of Aiken regarding urban storm water management; (c) community-based environmental restoration of low-income North Charleston neighborhoods; and (d) research of rapid transportation, including light rail, for a congested travel corridor in urban Greenville. To date, this CoEE has received over $1.5 million in federal and private research grant funding.

More than 75 Clemson faculty members and students in areas such as wetland ecology, hydrology, landscape architecture, computer sciences, electrical and computer engineering, and environmental toxicology are working together on Clemson's largest interdisciplinary project entitled Intelligent River **[see photo right]**. The Intelligent River Project focuses on the development of hardware, software, and modeling infrastructure to support real-time management of water resources across the state.

"When completed, this system will provide real-time information to the public, scientists and professional environmental managers. The system will supply hands-on practical information to help promote objective, science-based discussions about economic growth and the environment."

Dr. Gene Eidson, Intelligent River Project Director and Urban Ecology & Restoration CoEE Project Director

INFORMATION AND COMMUNICATION TECHNOLOGY

SOUTH CAROLINA COEE

CLEMSON UNIVERSITY

Cyber-Institute

Award Date: 2008 **Award Amount:** $2 million

Chair: Clemson is recruiting the HF FLAGSHIP ENDOWED CHAIR IN HUMAN-CENTERED COMPUTING.

The Cyber-Institute CoEE concentrates its research on developing, testing, and evaluating prototype cyberinfrastructure equipment and programs, leading to stronger collaborative environments for research, education and technology transfer at Clemson and throughout South Carolina. Objectives for this CoEE include increasing the level of research funding to build integrated cyberinfrastructure in the state; connecting research and scholarship in the field of CI to the commercial sector through corporate partnerships; expanding the creation and utilization of cyberinfrastructure resources in South Carolina; and developing an education and workforce development program.

"Cyberinfrastructure" (CI) is the term for hardware, software and networking tools that increases ease and efficiency of storing, processing and transmitting large amounts of data. CI helps researchers organize and coordinate data, enhancing their ability to manage projects and collaborate with colleagues in multiple locations.

SC LightRail

SOUTH CAROLINA COEE

In 2008, **SC LIGHTRAIL** went online. SC LIGHTRAIL is a dedicated, high-speed communication network which links the state's senior research universities to the National LambdaRail. (Think Super Internet: complex data feeds that once required considerable time to send now blaze across the state in mere seconds.) Funded by the General Assembly, SC LIGHT-RAIL offers multiple economic development benefits. It provides support for the develop-ment of new or expanding business segments that rely heavily on imaging (biomedicine, bio-engineering, etc.). It reduces costs by enabling universities to pool resources instead of purchasing duplicate systems. And it takes South Carolina's research universities to the next level of computing power—which makes our state more competitive for major research grants and serves as an essential recruitment tool to attract top CoEE Program faculty.

ADVANCED MATERIALS

SOUTH CAROLINA CoEE

CLEMSON UNIVERSITY

Image by **Daria Monaenkova**

NSF has granted five Clemson professors associated with the Advanced Fiber-Based Materials CoEE $2 million to develop nanofiber-based probes—needles 10 times smaller than a human hair—for medical diagnostics. The probes may save time and money compared to traditional methods of sampling fluids.

"This is like the procedure a butterfly uses to suck up its food," said Dr. Konstantin Kornev, Associate Professor in Clemson's School of Materials Science and Engineering. "It's interesting to see how these conduits that nature invented work."

Kornev cites one potential application as the ability to draw tiny samples of saliva from the glands of chemotherapy patients who often experience painful dry mouth as a treatment side effect. Other possible applications include extracting sweat from individual human pores or inserting new genes into cells.

Advanced Fiber-Based Materials

Award Date: 2006 **Award Amount:** $4 million

Chair: Clemson is recruiting the J.E. Sirrine Textile Foundation Endowed Chair in Advanced Fiber-Based Materials.

Research at this CoEE concentrates on the composition of novel fiber materials, fabrics and integrated components which possess unique functionality and value-added performance over traditional textile materials.

This CoEE is developing a niche industry in high-tech fibers and materials including fiber-reinforced composite materials based on metals, ceramics and polymers. A multimillion-dollar non-state match was donated by the J.E. Sirrine Textile Foundation. In honor of the Sirrine Foundation, Clemson coordinated a successful student recruitment for the polymer fiber chemistry undergraduate program, resulting in 28 new undergraduates for the Fall 2009 semester. CoEE research focused on capillary surface fibers applied in protein separation led to the 2007 creation of a start-up company, Specialty Custom Fibers, located in Pendleton, SC. To date, this CoEE has garnered over $2.4 million in federal and private research grants.

Optoelectronics

Award Date: 2008 **Award Amount:** $2 million

Chair: Clemson is recruiting the CoEE Chair in Optoelectronics.

This CoEE focuses on improving devices, systems and protocols used in high-speed optical communication networks and is part of Clemson's Center for Optical Materials Science and Engineering Technologies (COMSET). This CoEE advances research in optoelectronics and optical communications theory and practice and seeks to meet the industry need for higher data rates and lower latency for switching and routing in optical networks. This CoEE has received $1 million in funding from The Comporium Group, a communication services provider to Upstate South Carolina counties.

Optical Materials

Award Date: 2004 **Award Amount:** $5 million

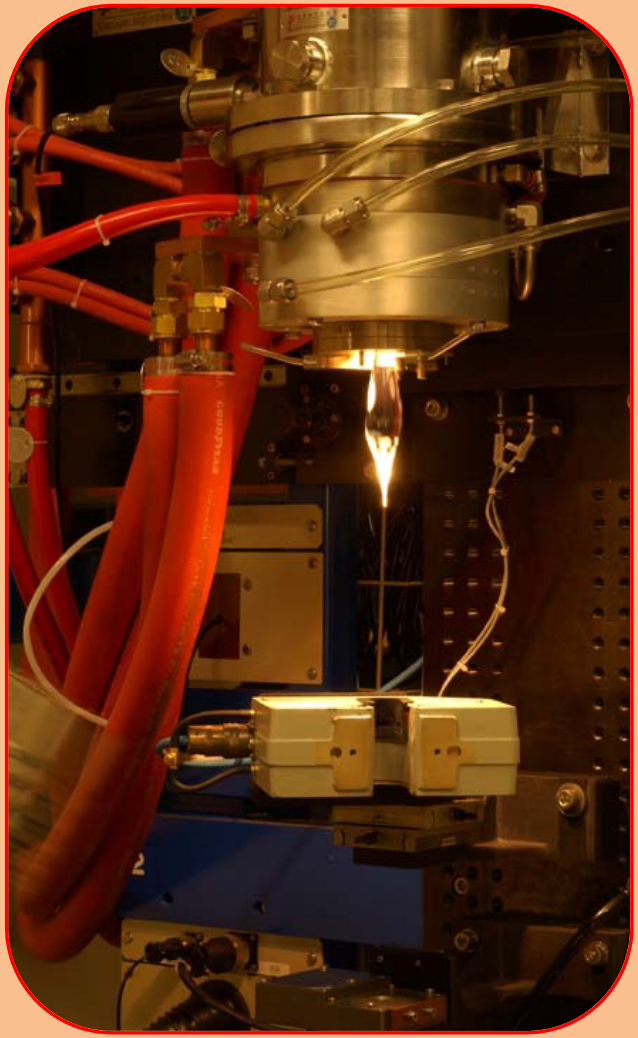
Chair: Clemson is recruiting the J.E. SIRRINE TEXTILE FOUNDATION CHAIR IN OPTICAL FIBERS.

This CoEE is affiliated with Clemson's Center for Optical Materials Science and Engineering Technologies (COMSET) and has received major funding from the J.E. Sirrine Textile Foundation. This CoEE focuses on the design, fabrication and testing of optical fibers for use in (a) directed energy systems critical to federal defense efforts, (b) communication systems for automobiles and information technologies, and (c) light-based biomedical therapies. The Optical Materials CoEE Chair will lead research in organic and inorganic materials for optical fiber and related photonic technologies.

Two consortia have been created to advance the development of new optical materials, devices and components in support of the existing photonics industry as well as the creation of new ventures in the Carolinas. The Carolina MicroOptics Triangle (CMOT) is a regional optics cluster among Clemson, UNC-Charlotte and Western Carolina University. CMOT added industrial affiliates in 2007 and is recognized as one of only four university photonics clusters in the nation. In 2008, Clemson partnered with Duke University and NC State University to establish the Carolinas Photonics Consortium.

The CoEE has launched two start-up companies: Advanced Photonic Crystals and Tetramer Technologies. In April 2009, Gulf Fiber Optics relocated a subsidiary division, its research unit, and four employee positions to Anderson in order to be near this CoEE's work. In FY2009, research partnerships were also formed with defense contractors Raytheon and Northrop Grunman. To date, the CoEE has received more than $8.7 million in federal and industrial research grants.

CoEE DISCOVERY: Optical Materials CoEE Principal Investigator Dr. John Ballato and his research team developed an optical fiber with a pure crystalline silicon core. Because it provides higher bandwidth, optical fiber is increasingly utilized in the transmission of mass communication, including Internet traffic. The switch to a silicon optical fiber would improve efficiency and reduce power consumption in light and electronic devices. It would also allow for the creation of more compact devices. Scientists have created optical fiber with a silicon core before; however, this creation uses standard mass-production methods, allowing for potential commercial viability.



The birth of optical fiber: Drop of glass at 4,000 degrees Fahrenheit, in the process of making optical fiber. Clemson University is one of only a handful of universities in the world with industry-level capability to make optical fiber.

CoEE Chairs Attract Top Students to SC

CU-ICAR students Evan Lowe (t) and John Limroth (b).

The CoEE Program Builds the Next Generation of South Carolina Scientists and Engineers

CoEE Chairs benefit the state by moving their research to South Carolina and attracting the brightest students who have their pick of international leading universities. Having this talent in South Carolina helps the state attract world-class companies and high-paying, knowledge-based jobs.

CU-ICAR hosts an automotive engineering graduate program with the nation's only Ph.D. in automotive engineering. John Limroth [bottom left] worked as an engineer for 10 years before pursuing a Ph.D. in automotive engineering at CU-ICAR. The Texas native cites the presence of CoEE Chair Dr. Thomas Kurfess as a big draw. During his decade in industry, Limroth followed Kurfess' work.

In addition to his CoEE research role, Kurfess directs the CU-ICAR graduate programs. The three other CU-ICAR CoEE Chairs are Dr. Todd Hubing (Electronics Systems Integration), Dr. John Ziegert (Automotive Design and Development), and Dr. Paul Venhovens (Automotive Systems Integration).

Student Evan Lowe [top left] agrees that professors make the difference when a student is choosing between prospective schools. Lowe, originally from Michigan, is also in the CU-ICAR Ph.D. program.

Lowe, who had been considering Michigan, recalls, "When I inquired about ICAR's automotive engineering program, Dr. Kurfess replied 15 minutes after I emailed him—and he was in Turkey!"

Lowe says that South Carolina and CU-ICAR made an excellent impression on him when he visited: "CU-ICAR has state-of-the-art equipment and several facilities under one roof. Usually you have to travel far to the test facilities that are sought by OEMs. They are usually not all under the same roof."

Lowe also says he is impressed with the engineering program's curriculum and its international focus, which includes business and requires students to learn a foreign language.

Limroth cites the opportunities to interact with private industry partners, both on joint research projects and through networking, as another advantage: "I would like to go into an R&D position in the auto industry with the goal of possibly returning to an academic setting down the road."

Limroth is interested in staying in South Carolina if opportunities are here. "We have enjoyed living in South Carolina and are definitely open to staying here."

Clemson University International Center for Automotive Research

MUSC Centers of Economic Excellence

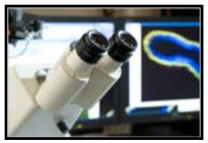
MEDICAL UNIVERSITY OF SOUTH CAROLINA
CENTERS OF ECONOMIC EXCELLENCE
2003-2009

Cardiovascular

Proteomics
Renal Disease Biomarkers
Regenerative Medicine
Advanced Tissue Biofabrication
Molecular Proteomics in Cardiovascular Disease and Prevention

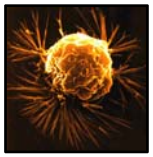
Neurosciences

Neuroscience
Stroke
Vision Science



Novel Technologies

Marine Genomics



Cancer

Cancer Disparities
Cancer Drug Discovery
Tobacco-Related Malignancies
Translational Cancer Therapeutics
Gastrointestinal Cancer Diagnostics
Cancer Stem Cell Biology and Therapy
Lipidomics, Pathobiology and Therapy

Healthcare

Clinical Effectiveness and Patient Safety
Medication Safety and Efficacy

MUSC
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"At MUSC, CoEE chairs were critical to our success in securing National Cancer Institute designation for the Hollings Cancer Center, the National Institutes of Health award in Clinical and Translational Research, and the $20 million National Science Foundation Tissue Engineering award. Our state is now on the national map as a major player in biomedical research as reflected by these highly coveted, peer-reviewed grants arriving within a few months of each other."

Raymond S. Greenberg
MUSC President

Clinical Effectiveness and Patient Safety

Award Date: 2006 **Award Amount**: $5 million **Collaborating Institution:** USC

Lewis Blackman CoEE Endowed Chair for Patient Simulation and Research for Health Sciences South Carolina: Dr. John Schaefer (MUSC)

CoEE Chair in Clinical Effectiveness & Patient Safety: Dr. Rita Snyder (USC)

CoEE Endowed Chair in Biomedical Informatics: Dr. Jihad S. Obeid (MUSC)

This CoEE improves clinical education and patient safety through the use of simulation technology. Its goals include improving the quality of delivered care, advancing the practice and training of the medical workforce from student nurses to practicing physicians, and becoming an international focal point for health sciences education and innovative research in education and safety. There are five operational CoEE Simulation Centers: MUSC, USC College of Nursing, Clemson University College of Nursing, Greenville Hospital System (GHS), Greenville Technical College, with two other Simulation Centers in development at USC Beaufort and Trident Technical College.

Since 2008, more than 14,000 students have participated in CoEE Simulation Center classes. B-Line Medical is creating a simulation learning management and data system and has engaged the CoEE in its development process. A start-up company, Sim Tunes, LLC, has been created to facilitate and license programmed clinical scenarios used in simulation classes.

Medication Safety and Efficacy

Award Date: 2008 **Award Amount**: $2 million **Collaborating Institution:** USC

Chair: MUSC is recruiting the CoEE Endowed Chair in Pharmacoepidemiology and Pharmacoeconomics.

This CoEE focuses on increasing drug safety and effectiveness, as well as decreasing medication errors by identifying the incidence and significance of adverse drug events that occur with prescription and non-prescription drugs. This data will be provided to hospitals, pharmaceutical companies, insurance companies, and governmental agencies (such as Medicaid and Medicare) for use in epidemiological and economic studies and will help lead to fewer drug injuries and improved drug effectiveness. In its first year, the CoEE had over $450,000 in federal research funding.

Marine Genomics

Award Date: 2003 **Award Amount:** $4 million
Collaborating Institution: College of Charleston
Chairs: MUSC is in negotiations for the CoEE Chair in Marine Bioinformatics and is actively recruiting the CoEE Chair in Marine Genomics.

The Marine Genomics CoEE researches marine functional genomics and bioinformatics, which includes the analysis of physiological adjustments in animal and plant genetics that result from environmental changes.

Investors and collaborators for this CoEE include Hollings Marine Laboratory (HML), the National Oceanic and Atmospheric Administration, and the S.C. Department of Natural Resources. In October 2008, the HML completed a 16,000 square foot expansion, dedicating 2,000 square feet to research space for this CoEE. This CoEE continues to sell diagnostic gene chips to the International Oyster Microarray Consortium on a cost-recovery basis, raising the profile of the marine genomics group in the international community. To date, the CoEE has partnered with two private companies, Shrimp Improvement Systems and Biogenmar, and is negotiating a formal relationship with a third company, Martek, to test the antiviral effect of algae incorporated in shrimp diets. MUSC is also negotiating a Materials Transfer Agreement with Mt. Sinai Hospital (NYC), which uses shrimp clones to study immune mechanisms in humans. Since inception, the CoEE has received $5 million in federal and state grant funding.

Taking on Killer Infections

by Bo Petersen

Agelas conifera is a common Caribbean sponge. Compounds from the sponge may help reverse antibiotic resistance.

A pristine sponge thrived in the middle of a dying Caribbean Sea coral reef. Peter Moeller wanted to know why. The answer might rock the worlds of human health and marine science.

Moeller, of James Island, led a research team that isolated a toxin compound in the sponge. The compound allows standard antibiotics such as penicillin to attack the most virulent, antibiotic-resistant bacteria—the kind that now defeats medicine's ability to fight them—killer staph infections and cholera. The finding could open a new door to saving lives.

"We have yet to find a bacteria we can't wipe out with standard antibiotics. We're doing something at the sub-molecular level and we don't know what it is," Moeller said. "We've pulled Superman's cape from these bacteria."

And wait, it gets better. The bacteria apparently don't recognize the com-pound as a toxin, so don't develop a resistance to it, as can happen with anti-biotics. The technique that found the compound could allow researchers to isolate other compounds that fight specific threats.

That could be the beginning of a day when antibiotic medicine can be customized for each patient, treating a specific infection without destroying other, healthy bacteria.

"We can now have personalized medicine," Moeller said. "Dial-an-Antibiotic."

His research is preliminary; the findings must now undergo exhaustive rounds of clinical testing. But the finding is stunning enough that his work is a lead presentation at the annual American Association for the Advancement of Science meeting under way in Chicago.

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NEUROSCIENCES

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SOUTH CAROLINA CoEE

CoEE Chair Dr. Gary Aston-Jones studies brain functions involved in learning, addiction and depression.

Neuroscience

Award Date: 2003 **Award Amount:** $3 million

William H. Murray CoEE Endowed Chair in Neuropathology: Dr. Gary Aston-Jones

Chairs: MUSC is recruiting the CoEE ENDOWED CHAIR IN MOVEMENT DISORDERS and the JOSEPHINE TUCKER MORSE ENDOWED CHAIR IN PARKINSON'S DISEASE RESEARCH.

The Neuroscience CoEE researches age-related neurodegenerative problems including dementia, Alzheimer's, Parkinson's and stroke. This area of research has a major impact on South Carolina, where over half the population is over the age of 56.

The CoEE has supported the creation of SemiAlloGen, Inc., a biotechnology start-up company which develops therapeutics in the field of neuro-degenerative disorders and cancer. This CoEE is developing a project with Jazz Pharmaceuticals to test mechanisms of action of the drug Xyrem. The CoEE has partnered with Cephalon Pharmaceuticals and Lilly Pharmaceuticals to test brain reward function.

The CoEE has received $4.2 million in research funding, which CoEE Chair Dr. Aston-Jones and his research team have focused on such subjects as drug addiction; a new rat model of depression; and brain circuits involved in circadian regulation of behavioral processes. The CoEE has collaborated with research teams at Princeton University, Tamagawa University (Japan), University of Texas at San Antonio, Harvard University, University of Bordeaux (France), and University of Pennsylvania.

Vision Science

Award Date: 2005 **Award Amount:** $4.5 million **Collaborating Institution:** University of South Carolina

MUSC Chairs: MUSC is recruiting a CoEE CHAIR IN GENE AND PHARMACEUTICAL TREATMENT OF RETINAL DEGENERATIVE DISEASE and a CoEE CHAIR IN BIOENGINEERING AND MATERIAL SCIENCE TECHNIQUES.

USC Chair: USC is recruiting a CoEE CHAIR IN GENE AND PHARMACEUTICAL TREATMENT OF RETINAL DEGENERATIVE DISEASE.

This CoEE focuses on gene and pharmaceutical treatments of macular degeneration, glaucoma, retinitis pigmentosa and other eye diseases. Partners include Alcon Labs, Alimera Scientific, Inotek Pharmaceutics, QLT Inc., Taligen Inc., and Pfizer. To date, over $1.7 million in research funds have been received for this CoEE. In 2009, the Storm Eye Institute, in which the Vision Science CoEE resides, purchased a Spectralis HRT+OCT—the only one in South Carolina—which allows researchers to translate efficiently basic findings into new therapies.

Stroke

Award Date: **2007** Award Amount: **$5 million** **Collaborating Institution:** University of South Carolina
CoEE Chair in Stroke: Dr. Robert Adams (MUSC)
Countess Alicia Paolozzi Chair in Translational Neurology: Dr. Marc Chimowitz (MUSC)
USC Chair: USC is actively recruiting the CoEE Chair in Translational Neurology.

The reduction in the incidence of stroke and the provision of acute stroke care are goals of this CoEE. This CoEE also enhances the existing stroke program at MUSC and strengthens the clinical and basic stroke research in South Carolina. With three endowed chair positions, this CoEE will increase translational stroke research and stimulate the development of new therapeutics, emphasizing drug discovery and biotechnology.

This collaborative effort enhances the research programs of MUSC, USC, Greenville Health Systems and the Greenwood Genetics Center. In May 2008, this CoEE implemented the REACH (Remote Evaluation of Acute Ischemic Stroke) Network. The network provides around-the-clock, Internet-based stroke consultation for patients within the first three hours of a stroke occurrence. Both MUSC and USC serve as hubs for this network, with "virtual spokes" reaching out to community hospitals throughout the state. Six community hospitals have already connected to this network, including McLeod Health (Florence), with five other hospitals considering connection. Doctors at MUSC treat stroke victims at community hospitals remotely with t-PA (Tissue Plasminogen Activator) thrombolytic therapy through telemedicine.

Because of the REACH Network, from May 2008 through June 2009, twice the number of stroke patients at REACH spoke clinics and hospitals were treated with t-PA therapy than were treated in the full previous year. The average telemedicine consult is only 11 minutes. With the activation of the REACH network, 56% of the South Carolina population is now within a 60-minute drive of tPA treatment compared to only 39% prior to REACH utilization. In the near future, the CoEE plans to extend the REACH Network to seven counties, with a coverage of almost 1,000 beds and 200,000 emergency room visits per year. To date, the CoEE has received over $1.3 million in federal and private research funding.

Stroke CoEE Chairs Dr. Robert Adams and Dr. Marc Chimowitz engage in a telemedicine stroke consult.

U.S. Senator Lindsey Graham *(l)* congratulates Former U.S. Senator Fritz Hollings *(r)* at the press conference announcing NCI Cancer Center Designation Status for the Hollings Cancer Center.

Gastrointestinal Cancer Diagnostics

Award Date: 2005 **Award Amount**: $5 million

Grace E. DeWolff Chair in Medical Oncology: Dr. Melanie B. Thomas

Additional Chair: MUSC is recruiting a CoEE Endowed Chair in GI Malignancy Diagnostic & Therapeutic Trials.

This CoEE researches translational medicine for GI cancer patients with the hope of decreasing cancer mortality and morbidity. Areas of research include molecular profiling, therapeutic targets, screening technologies, therapy and population studies, with particular emphasis on esophageal cancer, which is prevalent in South Carolina.

Partners for this CoEE include Roche Carolina and Bank of America. This CoEE has received $2.8 million in research funding to test novel therapies through clinical trials. CoEE faculty are conducting clinical trials in pancreatic, colon, kidney, liver and esophageal cancers. CoEE Chair Thomas is collaborating on a clinical trial with Cancer Drug Discovery CoEE Chair Charles Smith to test the success of a new drug for pancreatic cancer developed in Dr. Smith's CoEE laboratory.

CoEE faculty were instrumental in the awarding of a 2009 National Cancer Institute Cancer Center designation to the MUSC Hollings Cancer Center Center. In June 2009, MUSC also received a $20 million NIH Clinical and Translational Science Award.

2009 CoEE

Lipidomics, Pathobiology and Therapy

Award Date: 2009 **Award Amount**: $5 million

Chairs: MUSC is recruiting a CoEE Chair in Lipidomics and Pathobiology and a CoEE Chair in Lipidomics Drug Discovery.

This CoEE will translate basic lipidomics research into an understanding of how lipids play a role in health problems such as cancer, inflammation, and diabetes. Researchers will identify new targets for diagnostics or treatments. The CoEE has filed three invention disclosures, two focused on detection and monitoring of bladder cancer and one focused on blood screenings and identification of disease biomarkers.

Cancer Disparities

Award Date: 2008 **Award Amount:** $3.6 million **Collaborating Institutions:** USC, South Carolina State University
MUSC Chairs: MUSC is actively recruiting two CoEE Endowed Chairs in Cancer Disparities.
USC Chair: USC is actively recruiting a CoEE Endowed Chair in Cancer Disparities.

This CoEE will increase prostate cancer screening and early detection among African-American men. The specific goals of the CoEE are (a) to test methods of increasing African-American participation in prostate cancer clinical trials; (b) to develop tools and techniques to increase early-detection screening of African-American men for prostate cancer; and (c) to train students and faculty to conduct prostate cancer research.

Despite the fact that prostate cancer mortality rates in South Carolina are three times greater for African-Americans than for Caucasians, African-Americans are significantly underrepresented in prostate cancer clinical trials. A common barrier to the development of new knowledge for medical problems affecting racially and ethnically diverse populations is the ability to enroll diverse patients in medical research. The CoEE Chairs will conduct prostate cancer clinical trials and look at aspects of obesity and lifestyle modifications as contributing factors to prostate cancer. The CoEE chairs will also examine factors that influence the screening and treatment of African-American men.

The AT&T Foundation gifted MUSC's Hollings Cancer Center with $1 million to provide 500 African-Americans in South Carolina with free prostate cancer screenings and to provide treatment advice and education for men who receive abnormal test results.

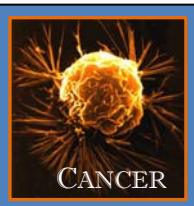
Tobacco-Related Malignancy

Award Date: 2007 **Award Amount:** $5 million
Chairs: MUSC is recruiting the BMW ENDOWED CHAIR IN CANCER RESEARCH and the ENDOWED CHAIR IN MOLECULAR EPIDEMIOLOGY.

This CoEE is devoted to discovering biomarkers of tobacco-related malignancies. The initial focus is lung cancer, but Center leaders also hope to make advances in other tobacco-related malignancies including head and neck, bladder and esophageal cancers.

In conjunction with the Hollings Cancer Center (HCC), this CoEE will partner with federal, state, and non-profit organizations to develop a distributed tissue repository and a clinical trials network. In 2008, HCC and this CoEE formed an alliance with the University of Colorado Comprehensive Cancer Center on the renewal of an NCI-funded Specialized Center of Research Excellence (SPORE) in Lung Cancer. Two faculty members associated with the CoEE, Drs. Gemmill and Drabkin, have clinical trials partnerships with Syndax, Pfizer and Novartis. Other faculty members associated with the CoEE enrolled a record number of patients with head, neck and thoracic cancers into therapeutic clinical trials this past year, representing 14% of patients in these disease areas seen at HCC.

Since inception, the CoEE has received over $3.8 million in federal and private research funding. The CoEE also participated in the application of the NCI Cancer Center Designation award and the $20 million NIH Clinical and Translational Science Award.



[CONT'D]

MUSC
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SOUTH CAROLINA CoEE

Cancer Drug Discovery

Award Date: 2005 **Award Amount:** $5 million **Collaborating Institution:** USC
Charles and Carol Cooper CoEE Endowed Chair in Pharmacy: Dr. Charles Smith (MUSC)
CoEE Endowed Chair in Advanced Technologies: Dr. John Lemasters (MUSC)
Additional Chairs: USC is recruiting the CoEE Chair in Medicinal Chemistry. MUSC is recruiting the CoEE Chair in Structural Biology.

This CoEE provides mechanisms for target identification and generation of lead compounds in the drug discovery process, thus creating a productive interface (currently lacking in the field) between academics and the biotechnology/pharmaceutical industries. This CoEE also develops research in structural biology for target analysis, chemical biology for designing drug candidates and advanced biomedical screening technology.

The CoEE's success is built upon the expertise and resources of its four endowed chairs (two appointed in 2006). One of these, Dr. Charles Smith, has formed a drug screening core that contains chemical libraries with 50,000 compounds. Using this screening core, Dr. Smith and another colleague identified compounds which inhibit PIM kinase enzymes which are over-expressed in cancer. An article about this discovery was published in the *Journal of Medicinal Chemistry*. Dr. Smith launched Vortex Biotechnology Corporation in FY 2009 to create marketable PIM protein kinase inhibitors to treat cancer. In 2009, another start-up company, SchnellGen, developed out of the work of the CoEE. Its mission is to develop novel therapeutics for the treatment of acute organ failure and wound healing. During 2009, the CoEE received more than $2.9 million in federal funding, while its overall total since inception is $9.6 million in federal research funding.

Cancer Stem Cell Biology

Award Date: 2008 **Award Amount:** $5 million **Collaborating Institution:** Clemson
Chairs: This CoEE has been awarded two CoEE Chairs, one in translational biomedical science and one in biomedical engineering.

This CoEE focuses on developing new technologies for isolating, growing and manipulating cancer stem cells. Cancer stem cells are adult stem cells that have the ability to reproduce themselves and develop into cancer. The CoEE will find ways to use adult stem cells from bone marrow or organs to treat cancer. The work of this CoEE will generate further understanding of cancer stem cells and ways to eradicate them without harming healthy cells. Research could also lead to the engineering of healthy adult stem cells that can replace cancerous cells in the body.

The CoEE will seek to add a repository of adult cancer stem cells to the Health Sciences South Carolina tissue repository for use in further research across South Carolina. To date, the CoEE has received over $1 million in federal research funding. Senior CoEE Personnel Dr. Bryan Toole and MUSC Pediatrics Professor Dr. Bernard Maria are studying the use of hyaluronan, a compound which resides on the surface of cancer stem-like cells, as a treatment for glioblastoma tumors. Hyaluronan, along with two other substances, regulate the activities of cancer stem-like cells. They are developing strategies towards a human clinical trial.

Translational Cancer Therapeutics

Award Date: 2004 **Award Amount:** $5 million **Collaborating Institution:** USC
John C. West Chair in Cancer Research: Dr. Kenneth Tew (MUSC)
USC Chair: USC is finalizing the search for the CoEE Chair in Drug Efficacy.

The Translational Cancer Therapeutics CoEE builds on existing strengths in pharmacology at USC and MUSC and expands opportunities for increased interdisciplinary research to enhance scientific research in the biology common to cancer.

Collaborative work with Novelos Pharmaceuticals has led to unrestricted research funding totaling over $750,000 since 2005 to study lung and ovarian cancer. A portion of this support funded a breast cancer clinical trial at MUSC, which in turn was instrumental in the pursuit and acquisition of the NCI Cancer Center designation for the Hollings Cancer Center. This CoEE was also instrumental in MUSC obtaining the NIH $20 million Clinical Translational Science Award, which was presented in July 2009. To date, federal funding for this CoEE totals over $5 million.

In 2007, this CoEE and CoEE Chair Dr. Kenneth Tew hosted the Hollings Cancer Center Spring Symposium on Cancer Drug Discovery/Drug Development at Kiawah Island. This event drew numerous pharmaceutical companies to the state and was an excellent opportunity for South Carolina drug researchers to showcase the state's prospects for drug discovery and development.

CoEE Chair Dr. Tew has an international reputation as a cancer drug discovery researcher and developer. His early research was pivotal in the design of treatment for hormone refractory prostate cancer. Tew's research has also proven instrumental in the late-stage clinical testing of two promising drugs, one for ovarian and lung cancer and another that serves as a modifier of bone marrow-mediated immune function. Tew is conducting research on how cancer cells develop resistance to different drugs. Discoveries from his work have suggested links between cancer and Alzheimer's. Tew sits on scientific advisory boards of a number of pharma-ceutical companies and has been awarded a National Cancer Institute Outstanding Investigator Grant as well as an American Cancer Research Society (ACS) Scientific Excellence Award. In 2008, Dr. Tew was elected as an American Association for the Advancement of Science Fellow. He is also President of the Association of Medical School Pharmacology Chairs.

CoEE Chairs Drs. Charles Smith *(l)* and Kenneth Tew *(r)*, demonstrate robotic high-throughput drug screening instrumentation.

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SOUTH CAROLINA CoEE

Proteomics

Award Date: 2003 **Award Amount:** $4 million

Chairs: MUSC is actively recruiting the CoEE Chair in Proteomics.

The Proteomics CoEE pursues research in technologies that study and gather information encoded in the genomes of proteins. Because of technology limitations, currently only limited protein information can be accessed and analyzed. However, the field of proteomics research is expected to lead to an understanding of cellular function at the molecular level, particularly how cellular functions go awry in disease.

To date, the CoEE has received over $5 million in federal research grants. This includes NIH funding for one of only ten National Heart Lung and Blood Institute Proteomics Centers in the country. Development of microfluidic devices for proteomic analysis by this CoEE has led to a new collaboration with The Citadel. [This collaboration will receive a portion of the $20 million statewide NIH EPSCOR grant for tissue biofabrication; awarded in July 2009.] Also, a new technology development in mass spectrometry for proteomic analysis in the form of a new dual mode ion source has led to an additional NIH grant. This CoEE continues its partnership with the U.S. Department of Energy Molecular Foundry at the Lawrence Berkeley National laboratory to develop a new type of microfluidic valve based upon a nanostructured polymer for use in proteomic analysis devices.

Renal Disease Biomarkers

Award Date: 2008 **Award Amount:** $5 million

Chairs: MUSC is actively recruiting the CoEE Chair in Renal Biomarkers and the CoEE Chair in Translational Nephrology Research.

This CoEE addresses the need for reliable and prognostic biomarkers, or biological indicators, for acute kidney injury and chronic renal (kidney) failure. Accurate and sensitive biomarkers are essential for early disease detection and treatment. This area of research is *especially* relevant in South Carolina: Diabetes is the leading cause of kidney failure, and South Carolina has a higher rate of diabetes than the U.S. average. According to the Centers for Disease Control and Prevention; more than 9% of South Carolinians have diabetes, compared to 7% nationally.

Faculty associated with the CoEE continue to partner with the Southern Acute Kidney Injury Network (SAKInet) made up of four researchers from Duke University, George Washington University, the University of Tennessee system, and the MD Anderson Cancer Center (Texas) in order to facilitate biomarker discovery. Two other consortia have been formed: BioMaSC (Biomarker SC) is comprised of nephrologists and primary care physicians across South Carolina, while MUSCRATS (MUSC Research and Translational Science) is comprised of MUSC alumni practicing nephrologists. To date, this CoEE has received over $900,000 in federal, foundation and industry research funding. This past year, the CoEE submitted a NIH grant application totaling $10 million in capital funds which would be used to create the Renal Biomarker Center.

Regenerative Medicine

Award Date: 2004 **Award Amount:** $5 million **Collaborating Institutions:** USC, Clemson

CoEE Chair in Regenerative Medicine: Dr. Richard Swaja (MUSC)

BlueCross BlueShield of South Carolina Foundation CoEE Chair in Cardiovascular Health: Dr. Martin Morad (USC)

Clemson Chair: Clemson is actively recruiting the Hansjorg Wys Endowed Chair in Regenerative Medicine.

Regenerative medicine is the regeneration of tissue and organs for the purpose of repairing, replacing and maintaining organ function. This CoEE combines statewide expertise in developmental biology, adult stem cell technology and tissue engineering. CoEE Goals include: (a) fostering basic research in genetics, proteogenomics, developmental biology, cell biology, and physiology of stem cells; (b) translating basic research into therapies for genetic and degenerative disorders; (c) collaborating with the private sector to develop business innovation research grants that can lead to partnerships with the business community and the federal government; and (d) establishing pre-doctoral and postdoctoral training programs in stem cell technology, developmental biology, biomaterials, and tissue engineering.

The most significant scientific accomplishments thus far are in the field of bioprinting, the assembly of living 3D human tissues and organs using rapid prototyping technology. In addition, advances in the multiple areas of bioengineering, wound healing, vascular biology, orthopedic materials science, and cardiac development have led to an effort to construct a biofabricated blood vessel network. To date, the CoEE has received in hand over $2 million in research funding for areas such as cardiac tissue engineering, implanted-associated infection, and battlefield skeletal injury. This CoEE will play a major role in the $20 million statewide NSF grant awarded in July 2009 for tissue and organ biofabrication.

Two research contract partnerships were developed this past year with Synthes USA. A start-up company, FirstString **[see page 16]**, was created in 2006, which features new wound repair technology; it has received investments and grants of more than $5 million.

CoEE Chair Dr. Martin Morad (appointed 2009) leads research efforts at the Regenerative Medicine CoEE to create the world's first biological pacemaker. Dr. Morad is an emblem of CoEE collaboration, holding faculty appointments at all three SC research institutions.

Advanced Tissue Biofabrication

Award Date: 2008 **Award Amount:** $5 million **Collaborating Institutions:** USC, Clemson

MUSC Chair: MUSC is actively recruiting the CoEE Endowed Chair in Biofabrication Biology.

USC Chair: USC is actively recruiting a CoEE Endowed Chair in Biofabrication Engineering.

Clemson Chair: Clemson is recruiting a CoEE Endowed Chair in Biofabrication Engineering.

The vision for this CoEE involves industrial-scale production of complex tissues and organs for the repair, replacement or restoration of diseased cells, tissues and organs. Researchers will focus on "bioprinting," assembling human tissues and organs by layering living cells and a hydrogel.

Previously, production of bioprinted tissue has been limited to cartilage and similar structures that do not require blood flow. CoEE researchers intend to generate a vascular supply for bioprinted tissue that would allow a larger variety of structures and organs to be created in this manner. Collaborations are being forged with the Polymer Nanocomposites CoEE, the Neuroscience CoEE and the Advanced Fiber-Based Materials CoEE.

The Advanced Tissue Biofabrication CoEE will play a major role in the implementation of the FY 2009 statewide $20 million NSF grant. Along with MUSC, nine other South Carolina institutions of higher education are participants in this project: Clemson, USC, Claflin University, South Carolina State University, Voorhees College, Furman University, USC-Beaufort, Denmark Technical College, and Greenville Technical College. According to Dr. Roger Markwold, lead scientist on the grant, the project's mission is "[building] tissue and organs from the inside out, which is a different approach than anyone has taken. First, we want to create a three-dimensional vascular tree and then the organ. This will allow us to develop the applications to build many different types of organs."

Molecular Proteomics in Cardiovascular Disease and Prevention

Award Date: 2006 **Award Amount:** $5 million

Chairs: MUSC is actively recruiting the Tourville CoEE Chair in Cardiovascular Imaging for Diagnosis and Prevention and the Volpe CoEE Chair in Cardiovascular Biomarker Development for Diagnosis and Prevention.

This CoEE advances cardiovascular (CV) prevention and treatment "bench" science into clinical "bedside" care. In FY 2008, the CoEE began a statewide network of five primary, separate care locations to participate and be linked by a central bioinformatics core. This core will allow patients who currently suffer or are at risk for CV disease across the state to be screened. In FY 2009, plasma screening was conducted for 450 patients. Through this screening, 16 plasma proteins were analyzed and a specific biomarker portfolio was created for the diagnosis and prediction of left ventricular hypertrophy and diastolic heart failure.

Stroke survivors Elizabeth Lafata (top) and Roberta Jordan are two of many rural SC stroke patients who have been saved by the Stroke CoEE REACH Network.

REACHing Out: Stroke CoEE Delivers Saving Care to Rural South Carolina Patients

Elizabeth Lafata and Roberta Jordan each suffered a stroke during the past year in rural South Carolina. The memory of that experience is vivid for both of them.

"I was in the gym on a bike," says Lafata, who was visiting South Carolina from Massachusetts when her stroke occurred. "I felt numbness in my legs, and I immediately knew something wrong. I got off the bike and knelt down on the floor, and by that time the numbness started going all through my legs and all through my arms. Thank God, my husband was there," she remembers. "I said, 'You better call 911.'"

Jordan, who lives in Conway, recalls her stroke. "I decided that I would put dishes up," she says. "When I went to put the pot in the utility cabinet, I dropped it. My head felt very strange." Jordan called her son, who lived across the street. "When he came in, I couldn't talk to him. So he called 911."

A stroke victim needs immediate medical treatment. A delay of even one hour can mean the difference between complete recovery and significant, permanent disability, sometimes even death. This reality puts rural stroke victims at a decided disadvantage. For them, the closest hospital is likely a smaller, community facility that lacks the resources of a stroke specialist on permanent duty.

Both Lafata and Jordan were taken to small hospitals following their strokes—to Waccamaw Community Hospital in Murrells Inlet and to Grand Strand Regional Medical Center in Myrtle Beach, respectively. However, Lafata and Jordan both had access to top MUSC neurologists in Charleston through a program called REACH MUSC which uses the Internet to connect stroke patients with stroke specialists.

The program is a research product of the Stroke CoEE at MUSC. CoEE Chair Dr. Robert Adams helped develop the system equipment, software, and decision support that are part of the REACH program.

REACH MUSC works in the following manner: when a stroke patient arrives at a partner site ER, he or she is identified as a likely stroke case. The local site then calls MUSC, and a stroke specialist connects to the partner site via a secure website. There, the physician views the patient via a web camera, studies medical information about the case, and reviews the patient's brain scan. The main purpose of this consultation is to reduce delay in using thrombolytic or clot-busting drug treatment, commonly known as tPA (tissue plasminogen activator).

"The painful reality is that despite having one effective treatment [tPA], the drug is vastly underutilized due to the narrow time window of its effective use, which is three hours from onset of stroke," says Adams. "The fact is that if the first hospital cannot administer the drug, the patient won't get it."

In the 12 months prior to implementing REACH, only 27 patients were treated with tPA at the six active REACH sites. After REACH was implemented, the active sites treated 56 patients with tpA from May 2008 through June 2009. This represents more than a twofold increase in the number of stroke patients treated.

"The great thing about the REACH program is that it offers state-of-the-art stroke care to people in small communities," says MUSC neurologist Dr. Tanya Turan. "The ER doctors at these outreach centers have been doing an excellent job of screening the patients that are appropriate for the REACH program. When we get a REACH call, we know that there's a pretty good chance that it's going to be a real stroke patient who really needs our help."

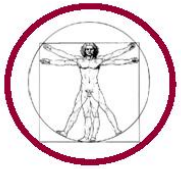
USC Centers of Economic Excellence

University of South Carolina
Centers of Economic Excellence 2003-2009

Future Fuels™

- Hydrogen and Fuel Cell Economy
- Renewable Fuel Cells for the Fuel Cell Economy
- Science and Engineering of Solid Oxide Fuel Cells
- Strategic Environmental Approaches to Electricity Production from Coal
- Nuclear Science and Energy
- Nuclear Science Strategies

Health Sciences



- Brain Imaging
- Childhood Neurotherapeutics
- Rehabilitation and Reconstruction Sciences
- Healthcare Quality
- SeniorSMART™

Nanotechnology

- Nanostructures
- Polymer Nanocomposites
- Nanoenvironmental Research and Risk Assessment

Tourism

- Tourism and Economic Development

UNIVERSITY OF SOUTH CAROLINA

"The CoEE Program represents an extraordinary and enlightened approach to economic development by our state leaders. Not only is it attracting national attention through investments in talent and infrastructure at USC, but it also is strengthening academic reputations and producing research that leads to higher-paying, knowledge-based jobs and, ultimately, a better standard of living for our citizens."

Harris Pastides
USC President

USC supports six energy-related CoEEs as part of its Future Fuels™ Initiative:

HYDROGEN & FUEL CELL ECONOMY
NUCLEAR SCIENCE AND ENERGY
NUCLEAR SCIENCE STRATEGIES
RENEWABLE FUEL CELLS
SOLID OXIDE FUEL CELLS
CLEAN COAL

University of South Carolina Future Fuels™ Initiative

Not to diminish American car drivers' pain at the pump, but the extravagant price we pay these days for a gallon of gasoline is only one of many woes besetting the global energy market.

Blame the unbending laws of supply and demand if you like—and it's true that the large populations of India, China, and other nations are joining the already ravenous U.S. thirst for gasoline and other forms of energy. But even if energy supplies were unlimited, the conjoined threats of greenhouse gas emissions and global warming would force us to consider alternative energy sources.

Can we have our energy cake and use it, too, without further deteriorating the environment? More to the point, what can energy research do to decrease American dependence on foreign oil, make electricity without making more greenhouse gas, and find viable ways to tap into renewable energy sources?

Harris Pastides, USC President

Our provost, Michael Amiridis, puts it succinctly: "The energy problems we face are complex, and the solutions are going to be equally complex—there won't be one magic bullet."

That's why we're focusing on several areas: hydrogen, PEM, and solid-oxide fuel cells, next-generation battery development, nuclear energy, photovoltaic cells, sustainable carbon usage, biomass, and energy conservation and efficiency. All of these are interconnected and could be part of the solution.

USC has solid credentials in energy research and is committed to becoming even stronger. South Carolina is home of the nation's only industry/university cooperative fuel cell research center, sponsored by the National Science Foundation and industry partners, and the Strategic Hydrogen Alliance will hold its national conference here in 2009. The University also has one of the world's top photonics research labs, whose research has yielded important applications in energy-efficient lighting.

In addition, the University has received a multi-million dollar research award to study clean coal technologies and will have recruited nearly a dozen new energy scientists by year's end.

Innovative energy research is crucial not only to America's sustainable economic development and well being but also to the ecological future of the planet. Scientists at the University of South Carolina aim to be at the forefront in that important work.

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Nuclear Science and Energy

Award Date: 2008 **Award Amount**: $3 million

Chair: USC is recruiting the CoEE Chair in Nuclear Power & Advanced Materials.

The Nuclear Science and Energy CoEE will focus on the design, development and analysis of advanced materials required to extend the life of existing nuclear power reactors and to develop a new generation of more efficient reactors. As the first order for new nuclear reactors in the U.S. in nearly three decades has recently been initiated, USC is poised to be a major academic leader in the field—especially as most nuclear engineering academic programs throughout the country have been terminated. South Carolina is already a national leader in nuclear power, generating 56% of its electricity via nuclear reactors.

In conjunction with the USC Nuclear Engineering program, this CoEE will have access to industrial partners including Duke Energy, Progress Energy, SCANA, Westinghouse, and the URS Nuclear Center. As proposed, the CoEE has three initial projects: (a) Coupled Design Codes and Thermal Hydraulic Test Data; (b) Advanced Materials and Processes for Study, Fabrication and Joining of Materials; and (c) Power Plant Maintenance and Monitoring. Research around these projects has the potential not only for aiding the nuclear energy industry but also for impacting the aircraft, gas turbine, coal and natural gas power plant industries.

Nuclear Science Strategies

Award Date: 2009 **Award Amount**: $3 million

Chair: USC is recruiting a CoEE Chair in Energy & Nuclear Security.

This CoEE aids and supports the thriving nuclear energy industry in South Carolina. Specifically, this CoEE will focus on project management and risk assessment in the planning, construction and operation of new nuclear power plants in the state.

The CoEE will work with the nuclear industry and the Savannah River National Laboratory to create new engineering and technological innovations and methods of project management to reduce the cost of new plant construction, enhance the security of nuclear power generation, and address related social and policy issues. CoEE researchers will partner with other higher education institutions including South Carolina State University and Clemson University to educate the next generation of nuclear engineers and technicians.

Dr. Travis Knight, co-principal investigator of both USC Nuclear CoEEs, works on a fluidized bed chemical vapor deposition coater to produce coated particle fuels for high temperature gas-cooled reactor applications.

Potential USC CoEE Nuclear Partners

FUTURE FUELS™ [CONT'D]

SOUTH CAROLINA CoEE

UNIVERSITY OF SOUTH CAROLINA

Strategic Environmental Approaches to Electricity Production from Coal

Award Date: 2007 **Award Amount**: $5 million

Chair: USC has announced the August 2010 appointment of Dr. Jochen Lauterbach of the University of Delaware as the CoEE ENDOWED CHAIR OF STRATEGIC ENVIRONMENTAL APPROACHES TO ELECTRICITY PRODUCTION FROM COAL.

Coal is the cheapest and most widely available energy source and will be used for at least another two to three decades by energy providers. However, the environmental impact of coal burning is substantial. The long-term research objective of the CoEE is to improve the environmental control technologies for coal power plants, including the design of improved environmental control systems for mercury and acid gas emission control and the development of new materials and processes for carbon sequestration and storage/ utilization.

Santee Cooper and the Electric Cooperatives of South Carolina are providing the non-state matching funds for this CoEE. Two research projects for this CoEE have been initiated: one on the refining of crushed coal by particle size, and the second on pressure swing adsorption cycles for CO_2 capture from coal-fired power plants. In FY 2009, this CoEE submitted grant proposals for over $1.9 million with the U.S. Department of Energy.

Dr. Michael Amiridis, USC Provost and Principal Investigator of USC's Clean Coal CoEE proposal.

Renewable Fuel Cells for the Fuel Cell Economy

Award Date: 2005 **Award Amount**: $3 million

Chair: USC is actively recruiting the CoEE Chair in Renewable Fuel Cells.

The mission of this CoEE is to coordinate state and local research projects to attract capital investment in South Carolina for the fuel cell economy. The CoEE is developing new catalysts that allow alternative fuels to be produced from renewable sources. These new catalysts are the "next wellhead" as the transportation sector moves to less dependence on imported oil and on carbon fuel. To date, the CoEE has received over $1.5 million in research funding. Work associated with this CoEE has led to the creation of a start-up company, Palmetto Fuel Cell Technologies.

Hydrogen Fuel Cells

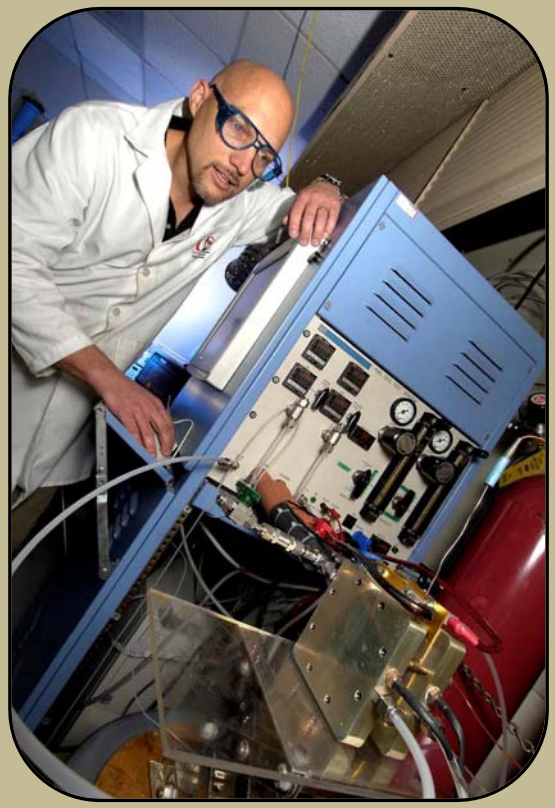
Award Date: 2004 **Award Amount**: $5 million

Chairs: USC is actively recruiting the CoEE Chair in Sensors and the CoEE Chair in Hydrogen Storage Materials.

This CoEE conducts research to develop hydrogen storage materials and sensors for fuel cells. Fuel cells produce electricity from hydrogen and hydrogen-rich carbon fuels without thermal combustion and are more efficient for power generation than coal and natural gas technology. One start-up company has been created through associated work of the CoEE: Hydrogen Hybrid Mobility. To date, this CoEE has received over $4.5 million in private and federal research funding.

This CoEE, along with the Renewable Fuels CoEE, participated in the April 2009 National Hydrogen Association Conference and Hydrogen Expo, held in Columbia. The conference bolstered South Carolina's position in the hydrogen industry.

Along with other components of the Future Fuels™ Initiative, both the Renewable Fuel Cells CoEE and the Hydrogen Fuel Cells CoEE will be housed in the Horizon Center, a $55 million public-private facility at USC Innovista. The chairs for these CoEEs will work with public and private sector alliances such as the S.C. Hydrogen and Fuel Cell Alliance and the Greater Columbia Fuel Cell Collaborative. USC presently has the nation's only NSF Industry/University Cooperative Research Center (I/UCRC) for Fuel Cells, which was renewed in FY 2009 for five years. As a part of this renewal, the I/UCRC has become a multi-university endeavor with the addition of the University of Connecticut and five member companies: IBM, Fuel Cell Energy, Northeast Utilities Foundation, Siemens and D-Star Engineering. These CoEEs have international collaborations with the Korea Institute of Energy Research and the Fraunhofer Institute for Solar Energy in Germany.



Dr. John Weidner, Associate Chair of Chemical Engineering at USC and Hydrogen Fuel Cells CoEE faculty member, tests a fuel cell.

FUTURE FUELS™ [CONT'D]

SOUTH CAROLINA CoEE

UNIVERSITY OF SOUTH CAROLINA

Solid Oxide Fuel Cells

Award Date: 2006 **Award Amount**: $3 million

CoEE Chair in Solid Oxide Fuel Cell Research: Dr. Kenneth Reifsnider

Solid oxide fuel cells (SOFC) are one of two leading fuel cell types which are expected to find commercialized application in large, high-power systems such as full-scale industrial and large-scale electricity-generating stations Solid oxide fuel cells convert chemical energy directly into electrical energy. Applications for these fuel cells include large-scale power distribution for municipalities, rural areas and industries, as well as energy for homes. They could also provide mobile power for computers, cell phones and other electronics. Solid oxide fuel cells are highly efficient; operate with a number of fuels, including renewable fuels; and produce very low amounts of greenhouse gasses and pollution.

Solid Oxide Fuel Cells CoEE Chair Dr. Reifsnider (bottom center) pictured with wife, his USC research team, and their families. Dr. Reifsnider is the only member of the National Academy of Engineering in South Carolina. The red scooter in the photo has been converted to run on hydrogen via solar paneling and electrolysis.

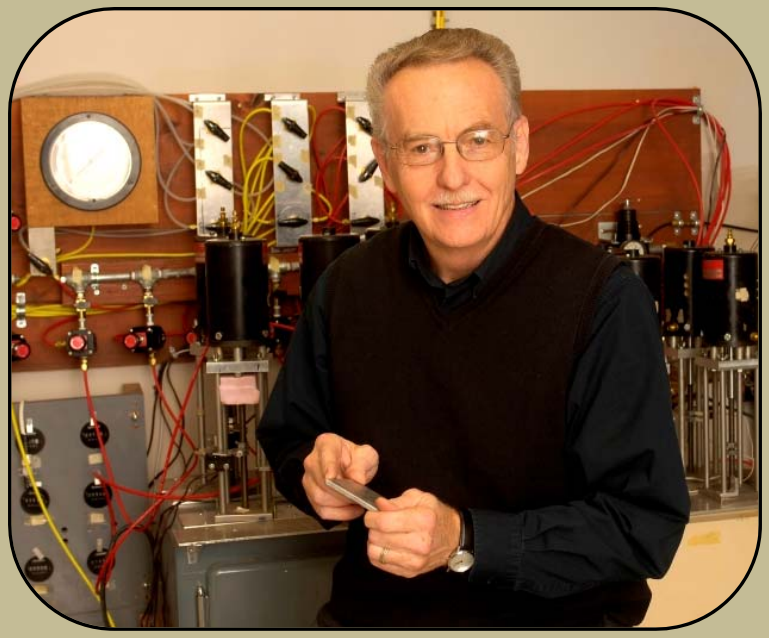
Solid Oxide Fuel Cell CoEE [cont'd]

This CoEE's goal is to remove barriers for the use of solid oxide fuel cells in society. A key element in this CoEE's success is its foundation in mechanical engineering, which is rare in SOFC research groups across the nation. CoEE Chair Dr. Kenneth Reifsnider's research focuses on the way materials "behave"—their durability, damage tolerance, performance over time. Dr. Reifsnider has co-founded a company called NextGenEn, Inc., which expects to market its first products by the end of 2009. Another company, NanoDynamics, is considering locating a manufacturing plant in South Carolina, in part because of the work of this CoEE.

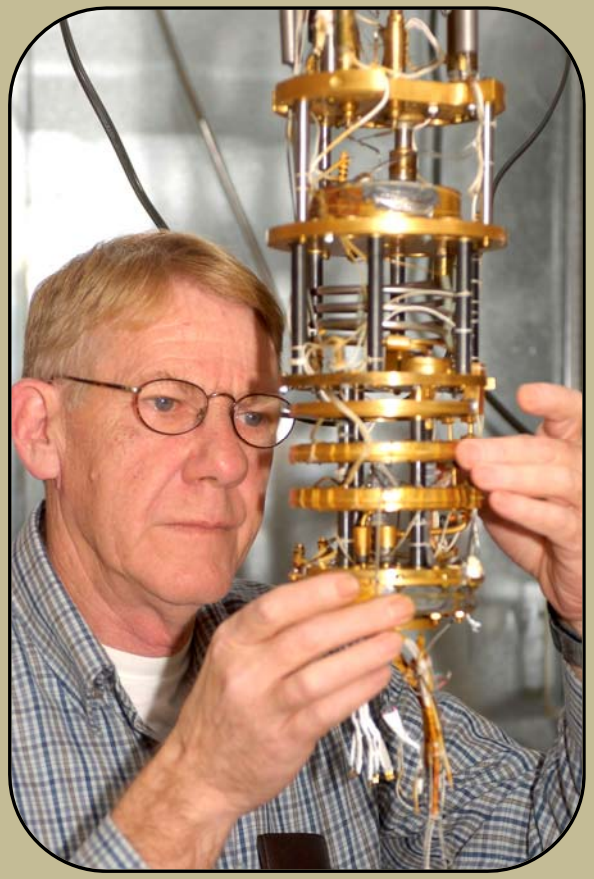
Currently, this CoEE has funding totaling more than $ 4.2 million from NASA, the U.S. Department of Energy (DOE) and the Savannah River National Laboratory. In FY 2009, faculty associated with this CoEE generated over $24 million in proposed research funding. This CoEE also has developed a collaboration with the Savannah River National Laboratory, the NASA Glenn Research Center and ENrG, Inc., to create a high temperature electrolysis system with NASA-invented fuel cell technology. The DOE Office of Basic Energy Sciences promised future funding if a working prototype system could be demonstrated in one year's time. SCRA granted $400,000 for the creation of the prototype system, which is currently being constructed.

CoEE MILESTONE: In May 2009, this CoEE was awarded a $12.5 million DOE Energy Frontiers Research Center (EFRC) grant. This CoEE will partner with four national laboratories and eight universities. This is the first time a research project of this size and scope has been led by USC, and it is also the largest single competitive award in USC history. The research will center on science-based nanostructure design and fabrication of materials used in engineering devices such as fuel cells, electrolyzers, electrodes, photovoltaics, combustion devices, fuel-processing devices, and functional membranes and coatings.

In his announcement of the EFRC grant, USC President Pastides stated: "This award solidifies the university's position as a leader in alternative-uel research. Moreover, it will advance the body of scientific knowledge related to alternative fuels and contribute to economic development in the Midlands and the Palmetto State." Dr. Reifsnider added: "It's a dream that I have had for more than 20 years. These are the things that I sometimes would wake up in the night and think about. We are leading a major effort at national and international levels."



Solid Oxide Fuel Cells CoEE Chair Dr. Kenneth Reifsnider.



CoEE Chair Dr. Richard Webb works wiring for his ultra-low temperature dilution refrigerator capable of cooling samples to 0.003 Kelvin (-459° F). A wide variety of ultra-low noise magnetic and electrical transport measurements on nanostructures have been made in this equipment the last two decades.

Nanostructures

Award Date: 2003 **Award Amount**: $4 million

CoEE Chair in Nanoelectronics: Dr. Richard Webb

The Nanostructures CoEE concentrates on research in experimental nanoscale physics and is positioning the state to compete in the global future electronics market. The program has five focus areas: (a) synthesis/characterization of nanowires in metals and semiconductors for novel magnetism in electronic circuits; (b) development of high power LEDs, transistors, and optoelectric properties of materials; (c) development of nanomagnetics, high frequency switching, and spintronics; (d) development of novel superconducting states/materials; and (e) discovery of novel concepts for nanoscale sensors for magnetic and structural properties. This CoEE is developing better and cheaper hydrogen gas sensors and multidimensional detection and analysis systems.

CoEE Chair Dr. Richard Webb's scientific accomplishments include fabricating some of the world's smallest electronic circuits, which could pioneer the development of smaller, higher-performing electronic devices. Products based on Webb's discoveries include sensors which diagnose heart problems and monitor internal faults in metal structures. Previously, Webb managed the quantum electronics program at IBM's T.J. Watson Laboratory. He is one of only two USC researchers who are members of the National Academy of Sciences and is a fellow of the American Academy of Arts and Sciences.

This CoEE's research achievements include progress in understanding the "coherence in magnetic nanostructures" and the importance of "biological systems in potential electronic applications." To date, the CoEE has received over $3.7 million in federal and private research funding. In 2008, the U.S. Army Research Office renewed its funding for the CoEE's sensors program. CoEE faculty, along with 16 national and international scientists, are forming an international materials institute with a concentration in Nanomechanics in Novel Materials. The institute has garnered a number of industrial partners, including a new industrial partnership with IBM T.J. Watson Research Center regarding magnetic tunnel junctions used for information storage. IBM supplies the devices while researchers conduct measurements.

Polymer Nanocomposites

Award Date: 2004 **Award Amount**: $3.5 million

CoEE Chair in Materials Science and Engineering: Dr. Brian Benicewicz

The South Carolina plastics industry accounts for nearly 5% of the Gross State Product of goods and services. As the plastics industry experiences commoditization of its basic materials (plastic polymers), this CoEE hopes to have a major impact on the state's manufacturing economy. This CoEE also is developing a research consortium to study the uses of nanomaterials to improve the performance of polyester polymers.

The CoEE is one of few national academic groups which has a complete system for making PET nanocomposites by in situ polymerization. The U.S. Air Force Research Laboratory has awarded research funding to the CoEE to construct and evaluate polymer nanocomposite structures for application in high energy storage devices. The CoEE anticipates further partnerships with several South Carolina capacitor companies, including KEMET and AVX. From 2007-2010, the CoEE will receive $600,000 in research funding from NSF for a Partnership for Innovation project; partner companies in this project include Michelin, MeadWestvaco and PBI Performance Products. BASF has granted research funding to this CoEE to develop the next generation of high temperature fuel cell membranes. To date, the CoEE has received over $1.6 million in research funding.

CoEE Chair Dr. Brian Benicewicz's work in high-temperature fuel cell membranes has resulted in a research contract with BASF which has developed fuel-cell units being used in European homes and portable power devices. In his work with polymer nanocomposites, he has designed new materials for electronics, optical, and other industrial applications.

"AN EXTRAORDINARY FIT"

What exactly are polymer nanocomposites? Polymers are compounds consisting of large molecules arranged in a chain of repeating molecular units. Among the many kinds of polymers, familiar examples include rubber (a natural polymer) and plastic (a synthetic polymer). Polymer composites are polymers that have been reinforced, giving them added strength.

But when it comes to the term polymer nanocomposites, no one would be faulted for wondering what effect incredibly small nanoparticles could possibly have on large molecules. In fact, their effect is nothing short of amazing.

"At the nano scale," Benicewicz says, "the surface area of a particle is so great compared to its volume that it starts to affect the properties of the entire composite. So it's almost realizing a dream: I can put a small amount of 'fairy dust' into a polymer and get a whole set of new properties."

[excerpt from *Breakthrough* printed with permission from USC]

CoEE Chair Dr. Brian Benicewicz *(r)* of the Polymer Nanocomposites CoEE reviews laboratory research with USC Ph.D. student Jessica Frankel.

NANOTECHNOLOGY [CONT'D]

SOUTH CAROLINA CoEE

UNIVERSITY OF SOUTH CAROLINA

Nanoenvironmental Research & Risk Assessment

Award Date: 2008 **Award Amount**: $3 million

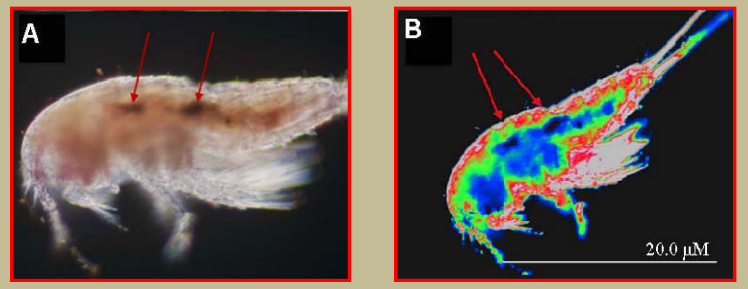
Chair: USC is recruiting the CoEE Endowed Chair for Nanoenvironmental Research and Risk Assessment.

The Nanoenvironmental Research and Risk Assessment CoEE will focus on the scientific, technological, health, economic, legal and societal effects of nanotechnology on the environment. Since nanomaterials are small enough to cross cell membranes, they are potentially toxic to living organisms, including humans. A growing demand exists for environmental health services in nanotechnology manufacturing and product assessment. Risk assessment tools are necessary to assure that socioeconomic benefits of nanotechnology are delivered without unacceptable risks of harmful effects on living systems and the environment.

In order to help meet this growing demand, the CoEE will build on USC's strong existing program of research in nanoscience, which includes the extensive facilities of the USC NanoCenter, the recently established W.M. Keck Open Laboratory for Bionanoparticle Technology Discovery and Development, and many partnerships with federal agencies and laboratories. The initial area of research for this CoEE will be the nanoparticle environmental impact on estuarine sediments and organisms. The U.S. Environmental Protection Agency has awarded the CoEE research funding totaling over $375,000 to study the effect of single-walled carbon nanotubes on estuarine sediments and organisms. The work of this CoEE has led to a collaborative scientific publication entitled "Transfer of Gold Nanoparticles from the Water Column to the Estuarine Food Web."

Materials structured at the nano scale can behave in a radically different manner compared to ordinary materials because nanomaterials have extraordinarily high surface-to-volume ratios—over 80% of the atoms are located at the surface of 1-2nm particles. This results in much higher chemical reactivities. Furthermore, nanostructured materials exhibit different physical and chemical properties which represent unique and exciting value propositions for Industrial applications and new products.

Some of these properties allow nanomaterials to be absorbed by plants, cross cell membranes and/or the blood-brain boundary opening up the possibility that these materials can be potentially toxic to living organisms including humans. U.S. annual federal nanotechnology expenditures in 2007 will exceed $1 billion.



The above images show (A) high levels and (B) confocal microscopy images of a copepod with multiple ingested single wall carbon nanotube aggregates traveling through its gut.

Tourism & Economic Development

Award Date: 2005 **Award Amount**: $2 million **Collaborating Institution:** Coastal Carolina University

Chair: USC has announced the January 2010 appointment of Dr. Simon Hudson of the University of Calgary as the CoEE Endowed Chair of Hotel, Restaurant and Tourism Management.

The purpose of the Tourism & Economic Development CoEE is to provide innovation to the tourism industry through the creation of new technological standards that will allow hotels, airlines, rental car companies, restaurants and destination marketers to operate more efficiently.

At present, technological applications such as software providers and web-based electronic commerce in the travel and tourism industry are severely outdated. As this CoEE makes new travel and tourism technology discoveries, it hopes to secure contracts with major corporations and tourism ministries as well as impact the South Carolina tourism industry. The CoEE's three primary goals include: (a) assisting technology developers and travel and tourism businesses to establish and adopt technological standards in hardware, software and web-based applications; (b) discovering and testing new technological applications based on new industry standards; and (c) evaluating the effects of new technology on organizational structures with the goal of increasing the efficiency of corporate management. This CoEE currently is developing international collaborations with universities and Ministers of Tourism in several countries, including China, Uruguay, Guatemala and Brazil.

This CoEE, its CoEE Chair and related faculty will forge collaborative partnerships with faculty in the USC College of Engineering and Computing. Other collaborative partnerships will be cultivated with Coastal Carolina University, Grand Strand tourism-related businesses, Clemson University, the Urban Land Institute, the South Carolina Department of Commerce and the South Carolina Economic Developers Association.

The Tourism & Economic Development CoEE focuses on tourism as an economic engine which attracts tech-savvy workers and entrepreneurs whom sociologist Richard Florida terms the "Creative Class."

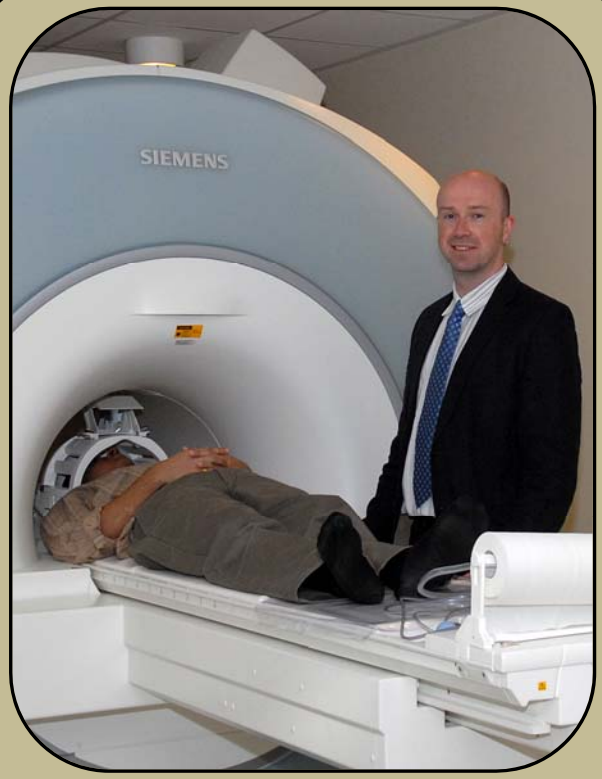
Brain Imaging

Award Date: 2003 **Award Amount**: $5 million
Collaborating Institution: Medical University of South Carolina
CoEE Chair in Brain Imaging: Dr. Paul Simon Morgan (MUSC)
USC Chair: USC is in final negotiations for the CoEE Chair in Cognitive Neuroimaging.
MUSC Chair: MUSC is recruiting a second CoEE Chair in Brain Imaging.

This collaborative CoEE is creating a world-class brain imaging center and is likely to spawn start-up companies in the areas of deception detection (lie detection) and minimally invasive brain stimulation technologies. Federal and private research funding to date is in excess of $7 million, and the CoEE has been selected to submit a proposal as the dedicated neuroimaging core for a $60 million U.S. Department of Defense Congressionally Directed Medical Research Program PTSD/TBI clinical consortium.

Two recently acquired MRI systems, a Siemens Trio MRI system and a Bruker 7-Tesla, attract important companies such as Glaxo-Smith Kline, Jazz Pharmaceuticals and BioValve, which use the systems to speed drug discovery and development in mood stabilizers, anticonvulsants and cognitive enhancers. The CoEE-launched facility, McCausland Imaging Center, located at Palmetto Richland Hospital, includes dedicated research space and scanner time, allowing scientists to conduct research with neurologically healthy individuals as well as clinical populations. In 2005, the CoEE launched the Center for Animal Imaging which provides translational research in substance abuse and epilepsy therapy. In 2008, MUSC also opened the Center for Advanced Imaging Research.

A CoEE partnership has been formed with Ladson-based Force Protection Industries (FPI). A leading manufacturer of tanks and armored vehicles, FPI will utilize CoEE research in the prevention of traumatic brain injury due to combat explosions. Tests have begun on "phantom" heads. Initially after the phantom heads are impacted by explosions, there appears to be little change in appearance. However, after further examination, the "brain" material shows an inability to transfer liquid, which parallels a human brain's ability to transfer information from one area to another. FPI will use this research to develop better explosive-resistant military vehicles, while the CoEE will use the findings to better detect and treat traumatic brain injury.



"The expansion of world-class MRI facilities at MUSC and throughout South Carolina for clinical and neurosciences research, combined with the statewide frameworks allowing genuine collaboration, provides a unique opportunity to build a critical mass of researchers. Working together with other researchers in the state, we can focus on successful and high-impact translational research using advanced MRI techniques."

CoEE Chair Dr. Paul Simon Morgan

Health Care Quality

Award Date: 2007 **Award Amount**: $5 million
Collaborating Institutions: MUSC, Clemson
CoEE Chair in Medical Bioinformatics: Dr. Iain Sanderson (MUSC)
CoEE Chair in Translational Clinical Research: Dr. Jay Moskowitz (USC)
MUSC Chair: MUSC is actively recruiting a second CoEE Chair in Brain Imaging.

This CoEE conducts innovative research on the state's major health problems, with the goal of improving the health of South Carolinians and the state's economy.

The CoEE has partnered with the S.C. Hospital Association for multiple benefits, including supporting statewide initiatives and translating new products and processes to hospitals. In February 2009, the S.C. Healthcare Quality Trust was launched as a partnership between this CoEE, Health Sciences South Carolina, the S.C. Hospital Association, and Premier, Inc. The goal of this partnership is to reduce healthcare-associated infections. According to data provided by Premier, Inc., a reduction of infections could save state hospitals up to $40 million a year and reduce patient stays by up to 24,000 days. As causes are determined and preventative measures tested, results will be shared with all 65 acute-care hospitals in South Carolina.

This CoEE is creating an electronic health portal and a clinical research organization, and has a partnership agreement with IBM and Siemens to assist with the formation of a statewide information technology infrastructure which will include a clinical data warehouse and clinical trials management systems. The CoEE has partnered with Collexis Holdings to form a database of biomedical research, the first such in the U.S.

CoEE Chair Dr. Jihad Obeid *(l)* of the Clinical Effectiveness & Patient Safety CoEE collaborating with Health Care Quality CoEE Chair Dr. Iain Sanderson *(r)*. Dr. Sanderson has received $2.8 million from the FCC to enhance rural healthcare through telecommunications and IT.

Childhood Neurotherapeutics

Award Date: 2006 **Award Amount**: $5 million **Collaborating Institution:** Medical University of South Carolina
USC Chairs: USC is recruiting the CoEE Chair in Child & Adolescent Neurochemistry and the CoEE Chair in Translational Therapeutics.
MUSC Chair: MUSC is actively recruiting the CoEE Chair in Neurodevelopmental Dysfunction Imaging.

This CoEE uses recent advances in pharmacogenetics, metabolic disorders, and neuroinflammatory diseases to study neurological disorders in children. Research at this CoEE focuses on the prevention of brain damage in premature infants and curing infant brain diseases through cellular engineering. In collaboration with the Greenville Hospital System, this CoEE operates a statewide team that is developing neural stem cell therapeutic approaches to neurological disorders in children. This important discovery will allow the CoEE to impact the treatment of these disorders and transfer research knowledge directly to patient application. This CoEE shares a FDA grant with the Philadelphia Children's Hospital to evaluate the efficacy of atorvastatin for Type I diabetes patients. These studies have resulted in a start-up company, ImmunoMod, which develops drugs for treatment of diabetes. To date, faculty associated with this CoEE have generated over $3.3 million in research funding.

HEALTH SCIENCES [CONT'D]

SOUTH CAROLINA CoEE

UNIVERSITY OF SOUTH CAROLINA

SeniorSMART™ Center

Award Date: 2007 **Award Amount**: $5 million **Collaborating Institution:** Clemson

USC Chairs: USC was awarded a CoEE Chair for Community and Social Support and a CoEE Chair for Memory and Brain Function.

Clemson Chair: Clemson was awarded a CoEE Chair for Senior Driving, Mobility, and Physical Functioning.

This CoEE focuses on research to foster independence for seniors via three components: SMARTBrain™ (maintaining intellectual activity); SMARTWheels™ (promoting independent mobility outside the home); and SMARTHome™ (maintaining independent mobility inside the home).

Collaborations for SMARTHome™ technology have begun with Lutheran Homes of S.C., Still Hopes Episcopal Retirement Community, and the Fraunhofer Institutes (Germany). One project involves a survey to determine seniors' acceptance of home technology and monitoring. Three levels of test homes are being created for SMARTHome™ research; Lutheran Homes of S.C. has donated two homes for laboratory settings, while Still Hopes is partnering with USC to create research laboratories at an Innovista facility. Several projects are being conducted for the SMARTBrain™ component on novel rehabilitative techniques for chronic stroke. One such project involves using video gaming systems to help seniors restore post-stroke movement and balance. The CoEE also has forged a SMARTWheels™ collaboration with CU-ICAR.

Another focus of this CoEE involves the detection and prevention of home falls by seniors. **[See profile on opposite page.]**

Rehabilitation and Reconstruction Sciences

Award Date: 2007 **Award Amount**: $5 million

Chair: USC will recruit a CoEE Chair in Reconstructive Methodologies and Materials.

The CoEE in Rehabilitation and Reconstruction Sciences is focused on medical and public health needs in the area of orthopedic disorders, exercise and sports-related injury prevention, treatment and rehabilitation. Collaboration among the four intellectual cores, Cellular Engineering; Rehabilitation and Performance Sciences; Epidemiology and Clinical Translation; and Education, help translate basic science to bedside care. The CoEE investigates the biologics of tissue-engineered materials and implantable devices to find solutions to a variety of musculoskeletal maladies.

Partners of this CoEE include Smith & Nephew, which in FY 2009 announced a $5 million non-state match for this Center. **[See interview with Smith & Nephew executive Ken Reali on page 11.]** Because of its partnership with this CoEE, Smith & Nephew has created a fifth unit of its company, the Biologics & Spine Division, which develops cutting-edge orthopedic therapies and technologies. Steadman Hawkins Clinic of the Carolinas and the Orthopaedic Research Foundation of the Carolinas serve as the clinical and educational practice partners for this CoEE. This CoEE will eventually create a clinical translational database to track the success of differing treatments, surgical outcomes and rehabilitation.

SC seniors Helen Coplan (t) and Bernie & Josie Shankman (b) benefit tremendously from SeniorSMART™ CoEE programs.

SeniorSMART™ CoEE Keeps Seniors Balanced and Independent

According to the Census Bureau, South Carolina's senior population is projected to grow by 133% by 2030. This increase has the potential to stress the state's healthcare and senior care infrastructure and raise the burden on taxpayers. To address this issue, the SeniorSMART™ CoEE focuses on multi-disciplinary research to develop products and programs that preserve older adult well-being and independence with the goal of allowing them to delay or avoid the need to enter a nursing home.

The Center focuses on areas relevant to the aging mind and body, such as ways to maintain a healthy brain, improve physical mobility and driving ability, and retrofit homes to suit older adult needs.

Unintentional falls are an especially common threat to seniors. According to the Centers for Disease Control, every 35 minutes someone in the U.S. over the age of 65 dies as a result of injuries from a fall.

The SeniorSMART™ Center is currently working on several programs and products designed to prevent many of the falls that can result in injury and detect falls immediately after they occur. The Center is also working on programs which include a balance class that addresses fall risk, as well as a mobility clinic that will incorporate a fall/risk assessment with therapy and interventions to keep older adults (and anyone with balance, gait or mobility issues) physically functioning and mobile.

According to SeniorSMART™ Assistant Director Dr. Deb E. Krotish, once the first mobility clinic is fully developed, it could be used across South Carolina and sold to other clinics across the country. The Center is also developing fall sensors that could be used in homes or hospitals. Krotish notes that the sensors will soon undergo field testing in order to become a marketable product.

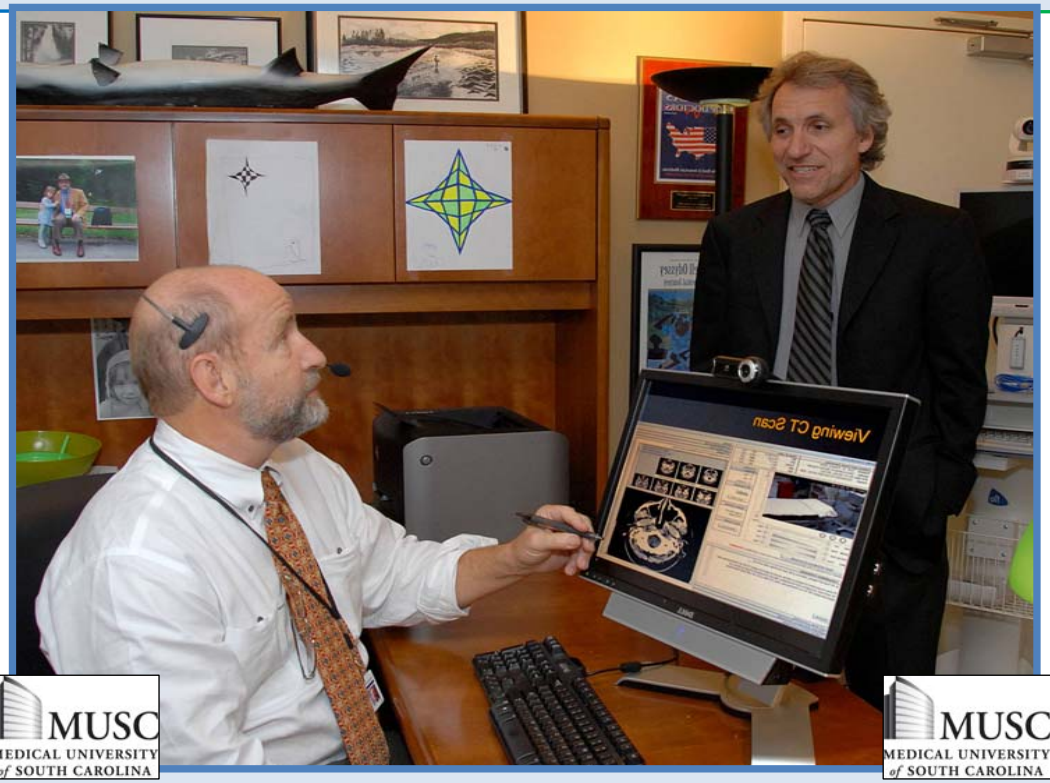
The Center's fall-prevention programs are already making a positive difference in the lives of South Carolina seniors. For instance, 90-year-old Helen Coplan of Columbia says the SeniorSMART™ program has improved her balance and given her confidence to keep doing the activities she enjoys, such as yoga and Tai Chi. The classes have also lessened her fear of falling. The program has "helped me realize what I need to do to lead a healthy lifestyle," says Coplan, who lives on her own and still drives.

Josie Shankman, 76, and her husband Bernie, 86, who live in Cayce, started the SeniorSMART™ balance program in January. "This program has helped both of us," says Josie. "It has affected everything from the way we walk to the way we take care of ourselves." Bernie says the program has helped him get around better in the dark and feel more confident in his day-to-day activities.

Through the help of the SeniorSMART™ Center, the Shankmans are more aware of the steps they should take to remain independent as long as possible.

CoEE Chair Profiles:
South Carolina's Research Stars

Dr. Robert Adams, CoEE Chair in Stroke in the Stroke CoEE. Dr. Adams' research is in clinical neurology, with a focus on preventing strokes and developing novel ways to deliver stroke care. He has established the REACH Network program, which connects neuroscience specialists with partner sites via the Internet to provide around-the-clock stroke care. Adams helped develop the company REACH Call, Inc. REACH Call provides system equipment, software and decision support for urgent specialist consultations via



Dr. Marc Chimowitz, Countess Alicia Paolozzi Endowed Chair in Translational Neurology in the Stroke CoEE. Chimowitz's research focus is neurodegeneration and treatments to prevent stroke caused by the narrowing of brain arteries. Chimowitz is leading a $25 million NIH-funded clinical trial on stroke prevention, one of the largest grants in SC history. At more than 50 U.S. sites, Chimowitz's team is examining the value of stents to prevent strokes in patients whose brain arteries have hardened and narrowed.

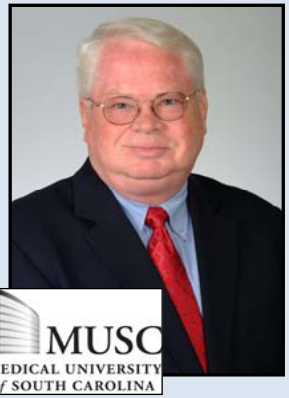
Dr. Brian Benicewicz, CoEE Chair in Materials Science and Engineering in the Polymer Nanocomposites CoEE. Benicewicz's research is in the areas of high-temperature fuel cell membranes, polymer synthesis, conducting polymers, and liquid crystalline polymers and thermosets. His work in high-temperature fuel cell membranes has resulted in a research contract with BASF. Benicewicz has also designed materials for electronics, optical, and other industrial applications.

Dr. Gary Aston-Jones, William H. Murray CoEE Endowed Chair in Neuropathology in the Neuroscience CoEE. Aston-Jones' research focus is motivation and cognitive processes, with particular emphasis on patient focus (the ability to concentrate and disengage on tasks) in certain mental disorders. In FY2009, Aston-Jones presented at six conferences, including the International Symposium on Drug Addiction Mechanisms and Therapeutic Approaches and the American College of Neuropsychopharmacology.

Dr. Todd H. Hubing, Michelin CoEE Endowed Chair in Vehicle Electronic Systems Integration in the Electronic Systems Integration CoEE. Hubing's research focus is the electronic automotive systems industry, with particular emphasis on systems compatibility. His research has applications for the development of a more practical electric-powered car. In 2009, he authored six academic publications and made seven presentations, including to the IEEE International Symposium on Electromagnetic Compatibility and the 20th International Zurich Symposium on Electromagnetic Compatibility. In 2009, Hubing was also named a Fellow of the Applied Computational Electromagnetics Society.

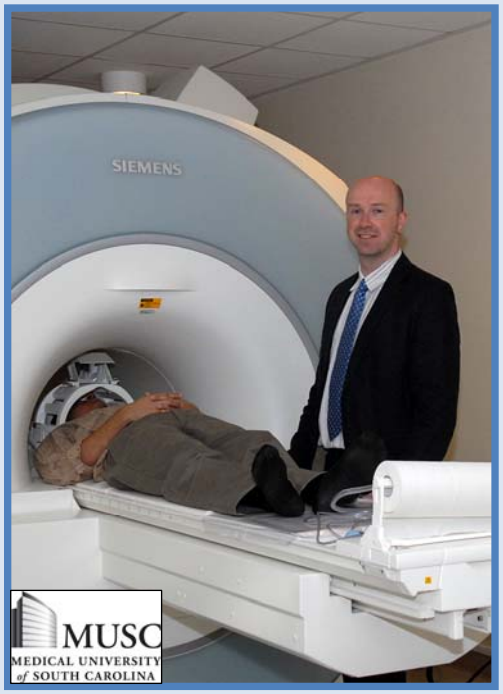
Dr. Thomas Kurfess, BMW CoEE Endowed Chair in Automotive Manufacturing in the Automotive Manufacturing CoEE. Kurfess' research focuses on precision systems, controls, automation, and robotics. In addition to automotive research, as director of the Carroll A. Campbell Jr. Graduate Engineering Center, he is preparing the next generation of engineers to work in the complex global automotive industry. In 2009, he received the honor of being elected as a Fellow of the American Association for Advancement of Science. In 2009, Kurfess delivered 30-plus presentations to corporations and civic groups, authored seven academic publications and presented at six industry conferences, including serving as keynote speaker at the Manufacturing Engineering Society International Conference.

Dr. John Lemasters, CoEE Endowed Chair in Advanced Technologies in the Cancer Drug Discovery CoEE. Lemasters is a pioneer of techniques that allow scientists to see inside cells during reoxygenation, which occurs following a heart attack or stroke. He specializes in microscopy that allows doctors to view slices of a single cell. His work helps researchers understand the mechanisms by which the liver is injured through chronic alcohol use and how donated organs are damaged while being held for transplant surgery. Lemasters holds five patents.



Dr. Martin Morad, CoEE BlueCross BlueShield of South Carolina Foundation Endowed Chair in Cardiovascular Health in the Regenerative Medicine CoEE. Morad is an internationally recognized scientist in the field of cardiac electrophysiology and calcium signaling. Morad seeks to discover what causes calcium signaling mechanisms in the cardiac muscle to stop working properly, which can result in congestive heart failure. Understanding this process could lead to new therapeutic approaches for congestive heart failure and other conditions. His work could lead to the world's first tissue-derived human heart pacemaker, which has great commercial viability as a replacement for current pacemaker technology made from artificial materials.

The CoEE Chairs are elite researchers bringing groundbreaking work to South Carolina thanks to the unified commitment to research and innovation by state government, industry and academia. Through the work of the CoEE Chairs, South Carolinians can look forward to a bright economic future.

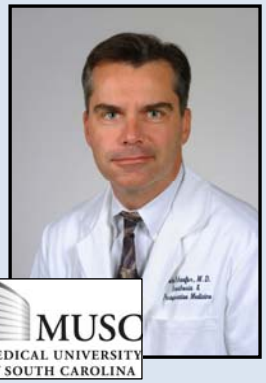


Dr. Paul Simon Morgan, CoEE Chair in Brain Imaging in the Brain Imaging CoEE. Morgan is an established innovator in the applications of Magnetic Resonance Imaging (MRI), especially related to the quantification of microscopic diffusion of water in tissues as a sensitive measure of subtle brain damage. He leads a team of scientists dedicated to translational medical research—applying advanced MRI techniques to better understand the development of neurological diseases and the effect of new treatments. Areas of focus include neurodegenerative diseases such as Alzheimer's disease and Parkinson's disease, with a particular interest in measures of patients with psychological problems, multiple sclerosis, and traumatic brain injury.

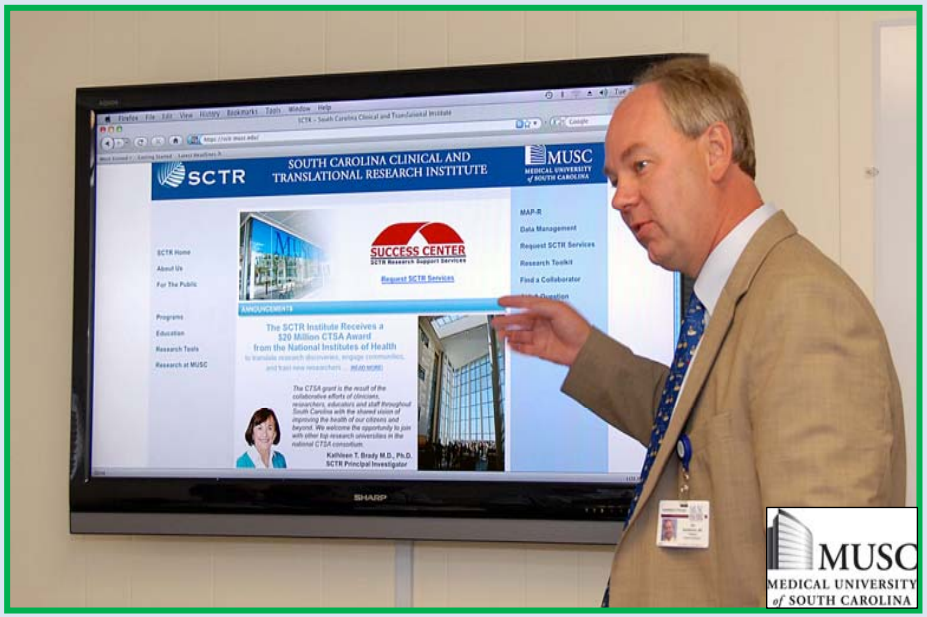
Dr. Jay Moskowitz, CoEE Chair in Translational Clinical Research in the Healthcare Quality CoEE. Moskowitz works to bring together healthcare systems, providers, and researchers to enhance patient care through clinical trials and interchange of electronic patient records. Through this interchange, first responders and medical teams will have instant access to an individual's medical history, which could raise care levels as well as the efficiency and profitability of healthcare providers. Moskowtiz also serves as President & CEO of Health Sciences South Carolina. He is recognized as a leader in biomedical research and research policy administration with more than 35 years of experience in federal government, academic medicine, and research.

Dr. Jihad S. Obeid, CoEE Endowed Chair in Biomedical Informatics in the Clinical Effectiveness and Patient Safety CoEE. Obeid is an expert in research databases and web-based clinical research systems, and is known nationally for developing innovative software to manage complex datasets in clinical settings. He works with information technology professionals throughout S.C. to develop software and infrastructure that help researchers share data and collaborate across hospitals and universities. By making clinical trial information easier to collect and analyze, medical informatics systems enable researchers to conduct rigorous studies and compare the effectiveness of different treatments for a given disease.

Dr. Kenneth Reifsnider, CoEE Chair in Solid Oxide Fuel Cell Research in the Solid Oxide Fuel Cells CoEE. Reifsnider's research is in the field of mechanical engineering, with a focus on the way materials "behave"—their durability, damage tolerance, and performance over time. His particular interest is in fuel cell science and engineering. In 2008, Reifsnider was named director of the USC Future Fuels Center. He previously served as director of the Connecticut Global Fuel Cell Center and as a Chair of Engineering Science and Mechanics at Virginia Tech. In FY 2009, Reifsnider was named to the Air Force Science Advisory Board by the White House. He is the only USC researcher who is a member of the National Academy of Engineering.



Dr. John Schaefer, Lewis Blackman CoEE Endowed Chair for Patient Simulation and Research for Health Sciences South Carolina in the Clinical Effectiveness and Patient Safety CoEE. Schaefer is working to reduce patient injury during airway management procedures using mannequin-based simulators. These procedures ensure that a person can breathe while receiving treatments such as anesthesia, CPR, or emergency medical attention. Prior to accepting his CoEE Chair position, Schaefer founded the Peter M. Winter Institute of Simulation, Education, and Research at the University of Pittsburgh Medical Center, one of the world's leading patient simulation facilities.



Dr. Iain Sanderson, CoEE Chair in Medical Bioinformatics in the Healthcare Quality CoEE. Sanderson leads initiatives in medical informatics across the state's four largest healthcare delivery systems and three research universities. The goal of his work is improving healthcare quality in South Carolina by creating secure databases for medical records that make it easier for healthcare systems to share vital information that is relevant for clinical trials and research. These improvements raise the level of care as well as the efficiency and profitability of the state's healthcare providers and could also help attract companies within the informatics field to the state.

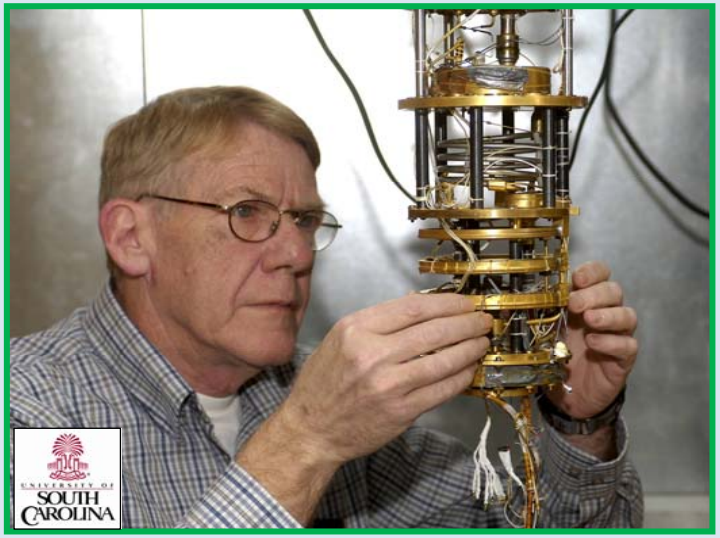
CoEE Program Endowed Chairs

Dr. Charles Smith, Charles and Carol Cooper CoEE Endowed Chair in Pharmacy in the Cancer Drug Discovery CoEE. Smith's research mission is to design drugs that fight cancer by unlocking molecular mechanisms important for tumor growth. This work could enable the development of drugs to fight a variety of inflammatory diseases, including arthritis, Crohn's Disease and diabetic retinopathy. Smith holds nine patents. He has held faculty positions at Duke, Penn State and the Fox Chase Cancer Center (PA).

Dr. Richard Swaja, CoEE Chair in Regenerative Medicine in the Regenerative Medicine CoEE. Swaja's research focus is regenerative medicine—the application of tissue engineering principles to restore the structure and function of damaged tissues and organs. Swaja is also director of the S.C. Bioengineering Alliance and is working to improve the state's bioengineering capabilities by developing a statewide research and education program to increase technology transfer between research institutions and S.C. companies.

Dr. Rita Snyder, CoEE chair in Clinical Effectiveness & Patient Safety in the Clinical Effectiveness and Patient Safety CoEE. Snyder's work emphasizes the use of health information technology to improve healthcare quality and safety. Her focus is on the integration and use of health information technology in SC's statewide network of medical simulation centers, which involve computerized mannequins that realistically simulate dozens of human functions. The Centers' goal is to provide a low-risk, high-quality educational environment for future clinicians to learn complex, high-risk healthcare procedures. Snyder's research addresses the impact of health information technology on clinical decision-making in a simulated environment, and the impact of simulation learning on patient care and healthcare setting outcomes.

Dr. Kenneth Tew, John C. West Chair in Cancer Research in the Translational Cancer Therapeutics CoEE. Tew has an international reputation as a cancer drug discovery researcher and developer. His early research was pivotal in the design of treatment for hormone refractory prostate cancer. Tew's research has also proved instrumental in the late-stage clinical testing of two promising drugs, one for ovarian and lung cancer, and another that serves as a modifier of bone marrow-mediated immune function. Tew is presently conducting research on how cancer cells develop resistance to different drugs. Discoveries from his work have suggested links between cancer and Alzheimer's. In 2008, Dr. Tew was elected a Fellow with the American Association for the Advancement of Science. He also currently serves as President of the Association of Medical School Pharmacology Chairs.

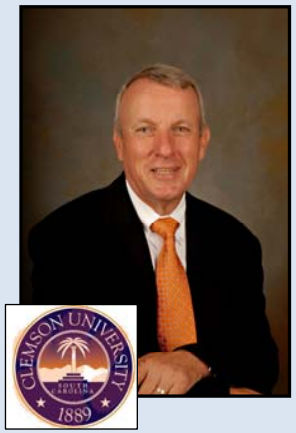


Dr. Richard Webb, CoEE Chair in Nanoelectronics in the Nanostructures CoEE. Webb is researching quantum devices for use in computer electronics and information technology. His scientific accomplishments include fabricating some of the world's smallest electronic circuits, which could pioneer the development of smaller, higher-performing electronic devices. Current products based on Webb's discoveries include sensors which diagnose heart problems and monitor internal faults in metal structures. He is a member of the National Academy of Sciences (one of only two USC researchers to hold that distinction) and is a fellow of the American Academy of Arts and Sciences.

Dr. Melanie B. Thomas, Grace E. DeWolff Endowed Chair in Medical Oncology in the Gastrointestinal Cancer Diagnostics CoEE. Thomas is a leading expert on gastrointestinal (GI) cancers, which include those of the stomach, liver, pancreas, colon, and elsewhere in the GI tract. Her research includes searching for new targets (proteins that play a role in the disease process and are the intended sites of drug activity) for GI cancer treatment and identifying new ways to screen for GI cancer. At MUSC, Thomas will develop a clinical trials program for liver cancer and will work with others to develop a robust research portfolio and clinical trials in other GI cancers. She is the principal investigator for 17 national and international clinical trials.

Dr. Paul Venhovens, BMW CoEE Endowed Chair in Automotive Systems Integration in the Automotive Systems Integration CoEE. Venhovens is a leader in the field of automotive systems integration; he brings both academic and industry perspectives to his role at CU-ICAR. Venhovens' research focuses on the testing of vehicle systems and their components to ensure efficient and safe operation. His research addresses the increasingly complex needs of the worldwide automotive industry, as a growing number of sophisticated electronic and mechanical systems must be smoothly integrated to create the cars of today and tomorrow. Venhovens came to the university from BMW's Research and Development headquarters in Munich, Germany.

Dr. John Ziegert, Timken CoEE Endowed Chair in Automotive Design and Development in the Automotive Design and Development CoEE. Ziegert's research is focused on designing automotive instruments and machines used in high-precision measurement and manufacturing. At CU-ICAR, Ziegert and his team are developing friction management and power transmission solutions that show promise for improving the manufacturing processes for a variety of industry sectors. He serves as president of Tetra Precision Inc., a Florida-based metrology company. He has been named to the College of Fellows of Society of Manufacturing Engineers.



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CoEE PROGRAM MISSION STATEMENT

The South Carolina Centers of Economic Excellence Program serves the public interest by creating incentives for the state's research universities, in cooperation with other institutions of higher education in the state, to raise capital from non-state sources to fund endowments for specialized research professorships. These professorships in turn serve as the nucleus for unique, university-based research centers which cultivate critical, public-private industrial partnerships, expand the state's knowledge base, create well-paying jobs, and enhance economic opportunities and improve the quality of life for the people of South Carolina.

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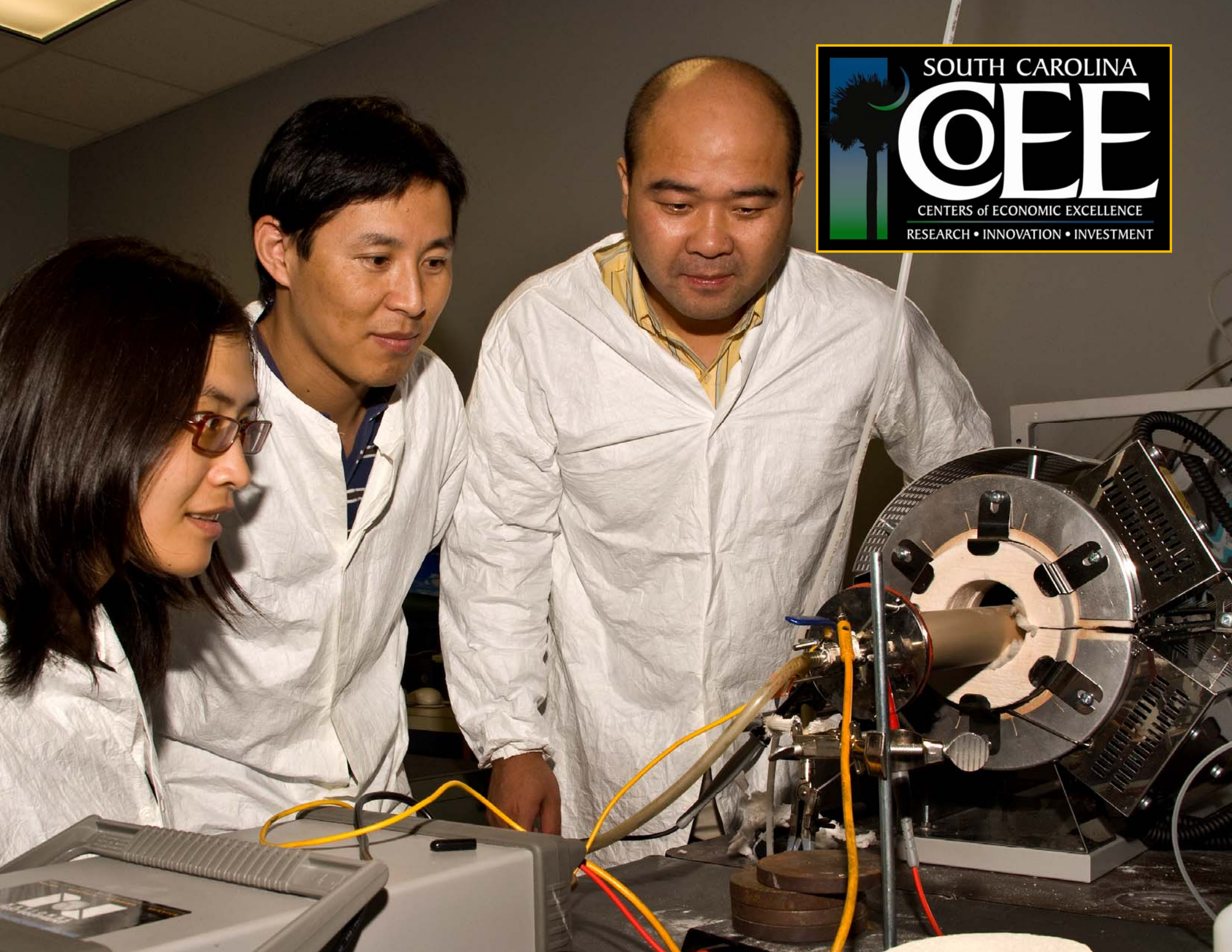
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